" A PROSPECTIVE STUDY OF THE OUTCOME OF TRAUMATIC DORSOLUMBAR FRACTURES TREATED WITH POSTERIOR STABILISATION BY PEDICLE SCREW FIXATION"

Dissertation submitted to
THE TAMILNADU DR. M.G.R. MEDICAL UNIVERSITY
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In partial fulfillment of the regulations for the award of the
M.S. DEGREE(Branch-II)

ORTHOPAEDIC SURGERY

GOVERNMENT MOHAN KUMARAMANGALAM MEDICAL COLLEGE, SALEM
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CERTIFICATE

This is to certify that **Dr.R.MUGUNDAN**, Postgraduate student(2012-2015) in the department of Orthopaedics, Government MohanKumaramangalam Medical College, Salem has done this dissertation**" A PROSPECTIVE STUDY OF FUNCTIONAL OUTCOME OF TRAUMATIC DORSOLUMBAR FRACTURES TREATED WITH POSTERIOR STABILISATION BY MOSS MIAMI SYSTEM"**under my supervision in partial fulfillment of the regulation laid down by the Tamilnadu Dr. M.G.R Medical University, Chennai for M.S., (Orthopaedics) degree examination to be held during April 2013.

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DECLARATION

I, **Dr.R.MUGUNDAN**, solemnly declare that this dissertation titled" **A PROSPECTIVE STUDY OF FUNCTIONAL OUTCOME OF TRAUMATIC DORSOLUMBAR FRACTURES TREATED WITH POSTERIOR STABILISATION BY MOSS MIAMI SYSTEM"**is a bonafide work done by me, at Government Mohan Kumaramangalam Medical College, Salem between the period 2010-2013, under the guidance of my unit Chief **Prof. Dr.A.D. SAMPATH KUMAR M.S.(Ortho)**, Associate professor of Orthopaedic Surgery. This dissertation is submitted to Tamilnadu Dr. M.G.R Medical University, towards partial fulfillment of regulation for the award of M.S.Degree in Orthopaedic Surgery.

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ABSTRACT

INTRODUCTION

The spinal trauma is one of the leading problems in orthopaedic practice, more so in modern era where the individuals are more at risk due to high energy trauma. Thoracolumbar spinal segment is the 2ndmost commonly involved segment after the cervical segment in spinal injuries, about 35 to 60% of all spinal injuries

occurring between T12 and L2.15 to 20% patients with fracture at thoracolumbar level have associated neurological injury. The treatment options for unstable thoracolumbar spine fractures and fracture dislocations have long been controversial. Many authors, advised non-operative treatment in the past, but nowadays, posterior instrumentation gives excellent outcome.

AIM OF THE STUDY

The aim of this study is to study the efficacy of pedicular screw and rod fixation system in achieving stability and clinical , neurological and radiological outcome in thoracic and lumbar fractures of spine.

MATERIALS AND METHODS

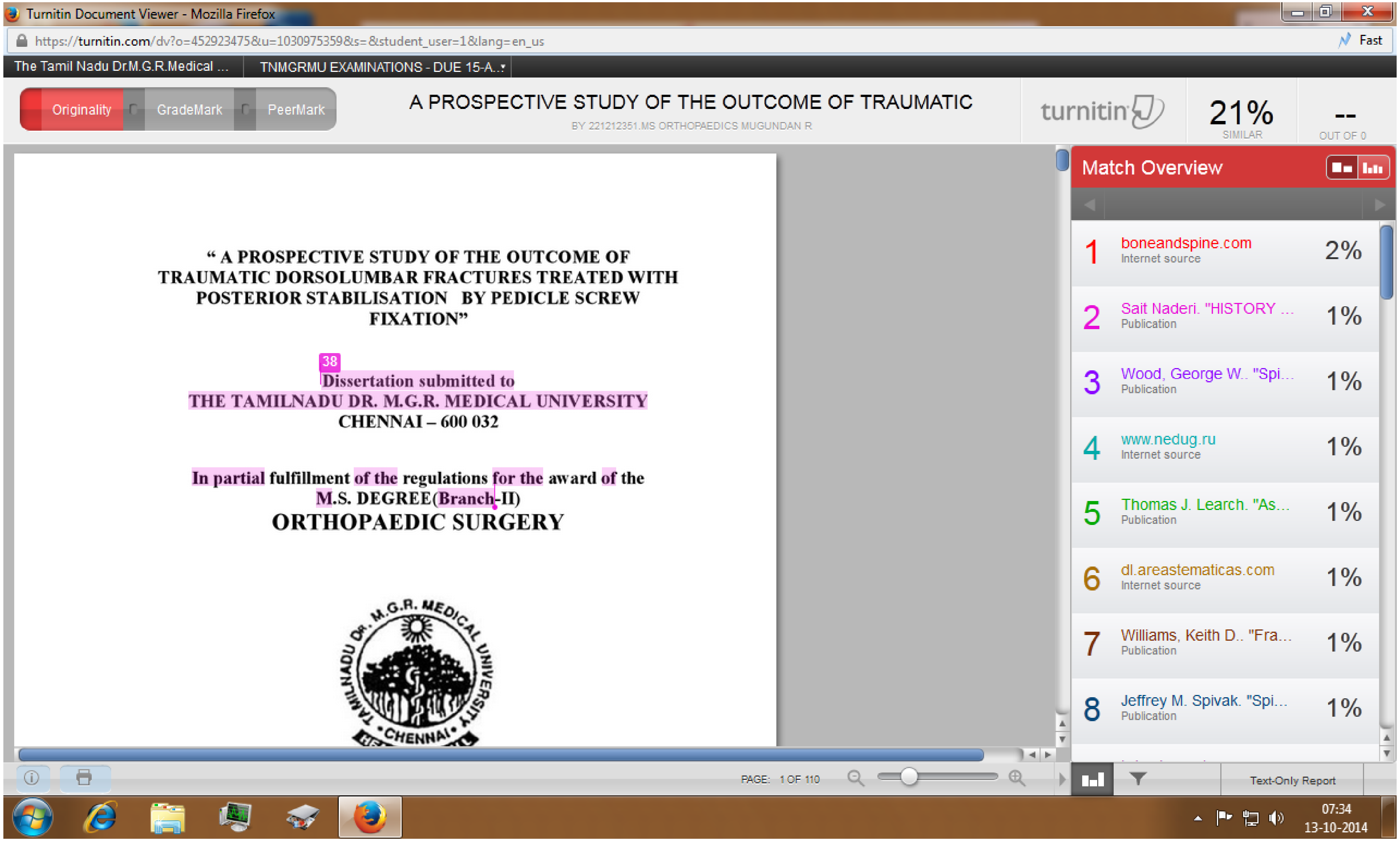
In all, a total of 20 cases were evaluated and assessed during the study period . The study was conducted in the Department of Orthopaedics, GMKMCH,SALEM.Pre operative x-rays CT,MRI were done and neurological status recorded.The clinical outcome was easured with Denis pain scale and Denis work scale.Neurological status was assessed with ASIA scale.Radiological outcome was assessed by measuring the regional kyphotic angle and anterior vertebral height.

RESULTS

In our study the clinical outcome was good.Most of the patients returned to their previous job and had a considerable reduction in pain.95% of patients had an improvement in their neurological status.There was a decrease in the regional kyphotic deformity and an increase in anterior vertebral height.1 patient had implant failure with decrease in the neurological status.1 patient had pedicle screw misplacement with no neurological complicationsand 1 patient had superficial wound infection.

CONCLUSION

Pedicle screw instrumentation provides less surgical exposure, correction of deformity and better stabilization .It provides fixation and stabilization of all the three columns.So stabilization,reduction and decompression using pedicle screws and rods helps in stabilization of unstable fractures and helps in further neurologic recovery of the patient.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INTRODUCTION

The spinal trauma is one of the leading problems in orthopaedic practice, more so in modern era where the individuals are more at risk due to high energy trauma[1].

It is one of the grave injuries that cause infinite morbidity and disability to the patient. By symptoms of numbness and palsy of the arms, the urine and the excreta coming against their will and knowledge, you may for tell that death is at hand for reason that the spinal marrow is hurt.

Thoracolumbar spinal segment is the 2nd most commonly involved segment after the cervical segment in spinal injuries, about 35 to 60% of all spinal injuries occurring between T12 and L2.15 to 20% patients with fracture at thoracolumbar level have associated neurological injury[2].

The treatment options for unstable thoracolumbar spine fractures and fracture dislocations have long been controversial. Many authors, advised non-operative treatment in the past, but nowadays, posterior instrumentation gives excellent outcome[3,4].

Historically, thoracolumbar fractures have been treated with recumbency i.e. to bed rest for a period of 8-12 weeks[5].This mode of treatment is accompanied with complication due to recumbency. It is very labor intensive, cost of therapy in terms of hospital hours used, bed occupancy and care by trained personnel is very high. In a country like ours, where there is acute shortage of hospital facilities and trained manpower, conservative management, and more often , end up as benign neglect, so there is an urgent need for exploring possibilities of surgical stabilization, early mobilizations and rehabilitation of patients.

Internal fixation and stabilization of spinal fractures allows early mobilization of all patients, regardless of neurological deficit, while protecting the neurological structures from further injury and enhancing their recovery[6].

Surgical treatment can be anterior, posterior or combined approach. As most orthopaedic and spinal surgeons are more experienced in posterior approach and at the same time this approach requires less operative time with less blood loss, hence a safe alternative[7,8,9].

Historically, Harrington hook rod construct or its modifications have been extensively studied[10]. their main disadvantage is that it spans 5-6 spinal segments[11]. Hence, newer options, especially pedicle screw plate or rod constructs which provide short segment immobilization have gained popularity[12]. The goals of surgery are to achieve stability, to correct deformity, early mobilization, to expedite post operative recovery and to decrease pseudoarthrosis. The pedicle screw plate or rod construct helps to achieve all these[13].

AIM OF THE STUDY

The aim of this study is to study the efficacy of pedicular screw and rod fixation system in achieving stability and assess the clinical , neurological and radiological outcome in thoracic and lumbar fractures of spine.

REVIEW OF LITERATURE

There is a lack of comprehensive reviews that consider the historical evolution of pedicle screw systems, the rationales for their application, and the clinical outcome. This literature review suggests that pedicular fixation is a relatively safe procedure and is not associated with a significantly higher complication risk than non-pedicular instrumentation. Pedicle screw fixation provides short, rigid segmental stabilization that allows preservation of motion segments and stabilization of the spine in the absence of intact posterior elements, which is not possible with non-pedicular instrumentation. Fusion rates and clinical outcome in the treatment of thoracolumbar fractures appear to be superior to that achieved using other forms of treatment[14].

The first documentation of literature related to spine biomechanics was derived from pre-Greco-Roman case histories, Egyptian and Indian origin. Among them is the work of Edwin Smith papyrus (2600–2200 B.C.), which is of great importance from the perspective of spine biomechanics.In this study, 48 cases of trauma were reported,including six cases of spinal trauma. Unfortunately,the portion containing thoracic and lumbar spine trauma was missing. This papyrus reported vertebral dislocations (*wenekh*) and burst fractures (*sehem*). It also presented evidence in support of mechanisms of injury(i.e., falling on one’s head [axial loading]resulting in a burst fracture.

Hippocrates worked on the anatomy and pathology of the spine . As an anatomist, his contributions were not remarkable. However, he stated that the spine was held together by means of intervertebral discs, ligaments, and muscles, and described the normal curvatures of the spine. He introduced two frames for reduction of the dislocated spine and associated deformities, including the Hippocratic ladder and the Hippocratic board. He adviced simultaneous traction of the spine and the manual application of focal pressure over the kyphotic area.

Surgical intervention for spinal injury evolved slowly The major obstacle was infection due to the lack of sterile surgical technique and effective antibiotics. Semmelweis and Lister worked on measures to prevent infection and this led to progress in invasive surgical procedures[15].

In 1886, MacEwen documented the first laminectomy.

In the early 1900s Menard introduced the costotransversectomy.

In 1891,, Berthold Earnest Hadra performed dorsal stabilization of a cervical fracture–dislocation .

In 1909, Fritz Lang used rigid rods and steel wires on either side of the spinous processes to stabilize the spine. Lang discovered that internal fixation induced more timely healing than immobilization therapy alone.He utilized foreign materials to stabilize spine in patients affected with tuberculosis and poliomyelitis ,suffering from kyphoscoliosis[15].

In 1895, Wilhelm Conrad Röntgen used radiographic imaging to obtain anterioposterior views of the spine.

In 1925, Davis took lateral view of the spine.

The invention of Harrington rods was a major breakthrough in the evolution of treatment of spinal deformities.Harrington used distraction to correct the deformity.

Luque used sublaminar wires for segmental fixation of spine.This paved way for correction of spinal deformities in both coronal and sagittal planes[1].

Zielke and Dywer discovered anterior approach and instrumentation for better correction of spinal deformities in 1970.

The introduction of pedicle screws, for dorso lumbar fractures increased the ability of surgeons to correct the deformities far better. The history of spinal deformity is still maturing as newer procedures are being invented.

The past decade has seen a dramatic increase in the availability of spinal instrumentation devices, enabling surgeons to treat a variety of spinal disorders with improved results and lower morbidity. Segmental hook fixation of the posterior thoracolumbar spine paved way for improved correction of deformity without increased morbidity or the need for postoperative bracing in many cases. Finally, the use of transpedicular screw fixation of the lumbosacral spine allows for excellent segmental fixation without intact posterior elements, including facet joints, and has significantly improved the fusion rate in thoracolumbar fusions[16].

Thoracolumbar fractures are relatively common injuries. Numerous classification systems have been developed to characterize these fractures and their prognostic and therapeutic implications. Recent emphasis on short, rigid fixation has influenced surgical management. Patients with unstable burst fractures and neurologic deficits require direct or indirect decompression. Posterior stabilization can be effective with Chance fractures and flexion-distraction injuries that have marked kyphosis, and in translational or shear injuries[17].

Pedicle Screw Instrumentation: The use of pedicle screw instrumentation in the spine has evolved over the last two decades. The initial use of pedicle screws began in the lumbar spine, the use of pedicle instrumentation has evolved to include their use in the thoracolumbar and thoracic spine. Improved deformity correction and overall construct rigidity are two important advantages of pedicle screw instrumentation due its three-column control over the spinal elements. First, pedicle screw instrumentation obviates the need to place instrumentation within the spinal canal with its inherent risk of neurologic injury. Second, the placement of pedicle screws is independent of facet or laminar integrity and thus has been extremely useful in traumatic, neoplastic and degenerative conditions[18].

A biomechanical study carried to investigate the effect on flexion, extension, and rotation of seven systems of fixation on five cadaveric lumbar spines. Pedicle fixation proved the most effective method to restrict these movements. Facet screw fixation was also successful. Harrington distraction rods, the Hartshill rectangle and the Luque technique, although restricting slight flexion and extension, exerted little control over rotation[19].

HARTSHILL RECTANGLE

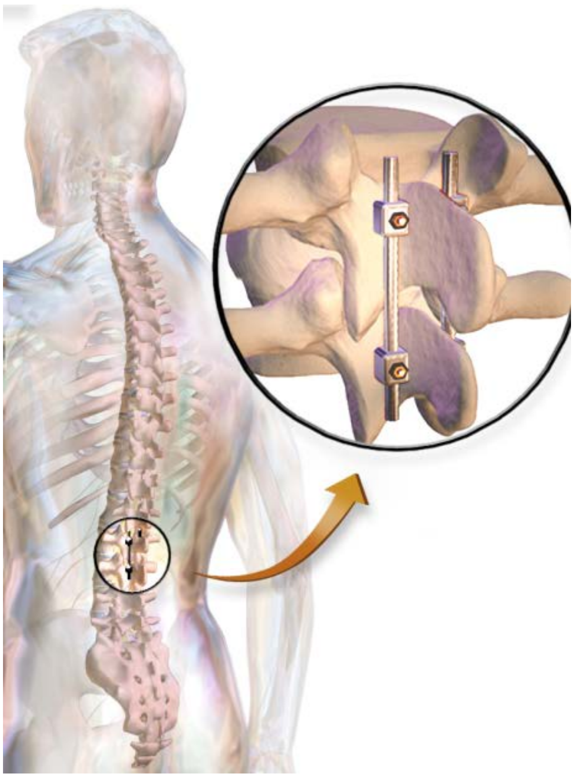
In a randomized study of patients presenting with acute burst fractures of the thoracolumbar and lumbar spine. Patients were alternately treated by posterior distraction using pedicle instrumentation or anterior decompression and instrumentation. Forty patients are presented with a mean follow-up of 20 months. At last follow-up, the mean improvement in kyphotic deformity was 9.3 degrees in the anterior group and 11.3 degrees in the posterior group. There were no complications from thoracotomy and anterior decompression of the dural sac. This study supports the hypothesis that posterior distraction instrumentation can effectively decompress the canal and correct kyphosis in patients sustaining burst-type injuries. Anterior surgery, however, results in a more complete and reliable decompression of the canal[20].

Roy-Camille et al. performed fixation of thoracolumbar fractures with pedicle screws and plates in 1961[21].Pedicle screw and plate implants for spinal fractures were developed by Steffee and Sitkowski, Luque, Roy-Camille, and others. One advantage of pedicle screw devices is that they allow the surgeon to apply translation and angulation independently to the spine.

Oda and Panjabi examined five “device adjustments” (pure compression, pure distraction, pure extension, a combination of distraction and extension, and neutral posture) in a biomechanical study of pedicle screw instrumentation. They found that construct stability had a complex association to device adjustment. The maximal flexion and extension stabilities were achieved by pure compression and distraction-extension combination adjustments. Pure distraction and pure extension adjustments decreased construct stability.

A study was conducted with 90 cases of unstable dorsolumbar fractures using pedicle screw plate of modified Roy- Camille system.The follow up period was two and a half years.It was found that 74% of the fractures were reduced completely and there were only few complications.Early mobilization was done in these patients[22].

Harrington rods: Posterior stabilization of dorsolumbar fractures with Harrington's instruments was introduced in 1980 and practiced. Complications were implant failure or hook dislocation, infection, and bleeding[23] .



HARRINGTON ROD

Universal Spine System with shortened Schanz screws.

Various devices and techniques are used in the thoracic and lumbosacral spine[24] Pathologies of which pedicle screw is one of the commonly used device in spine trauma in recent years.

Between January 1989 and July 1992, 76 patients with thoracolumbar fractures were operatively treated. In 40 cases the dorsal instrumentation was combined with transpedicular cancellous bone grafting. In this series, two complications were observed: one iatrogenic vertebral arch fracture without consequences and one deep infection. The assessment of complaints and functional outcome with the "Hannover Spinal Trauma Score" reflected a significant difference between the status before injury and at the time of follow-up. The radiographic assessment demonstrated a significant mean restoration from an initial angle of -15.6 degrees (kyphosis) to +0.4 degree (lordosis).[25]

Three cadaver lumbar spines were instrumented bilaterally with pedicle screws from L1 to L5. Thirty pedicles had 6.0 mm AO pedicle screws inserted using standard surgical technique. Seven directions of deliberate misplacement as well as correct placement of screws were performed at random levels for a total of eight possible screw positions. The spines were then dissected to visualize the screws and their position related to the pedicle. After determining the true position of the screws, a systematic method was designed. Using conventional radiographs, 63%

of the screw placements were correctly identified as in or out of the pedicle. Computed tomography improved accuracy to 87%. Identifying the true directional component of screw position led to a decrease in accuracy (conventional radiographs 37% and computed tomography 47%)[26].

In variable screw placement system (VSP) the fixation achieved is more rigid as the screw is passed through the "force nucleus" of the vertebrae. This is the point through which five anatomical structures – the superior facet, the inferior facet, the lamina, the pedicle and the transverse process; channel all posterior forces that are transmitted to the body.

STEFFEE PLATE

In this study, we stabilize the cases of the unstable thoracolumbar spine injuries with decompression and either pedicular screw and rod instrumentation. We have evaluated all patients for maintenance of spinal correction and neurological improvement after posterior instrumentation in thoracic and lumbar spinal fractures and clinical outcome in terms of spinal scoring system called as Denis work and pain scale.

RELEVANT ANATOMY

The human spine also known as vertebral column is made of individual units called vertebra. The name vertebral column is derived from its appearance when viewed from the front it really looks like a column[27].

The anatomical structures can be broadly classified into two.

A. Spinal column

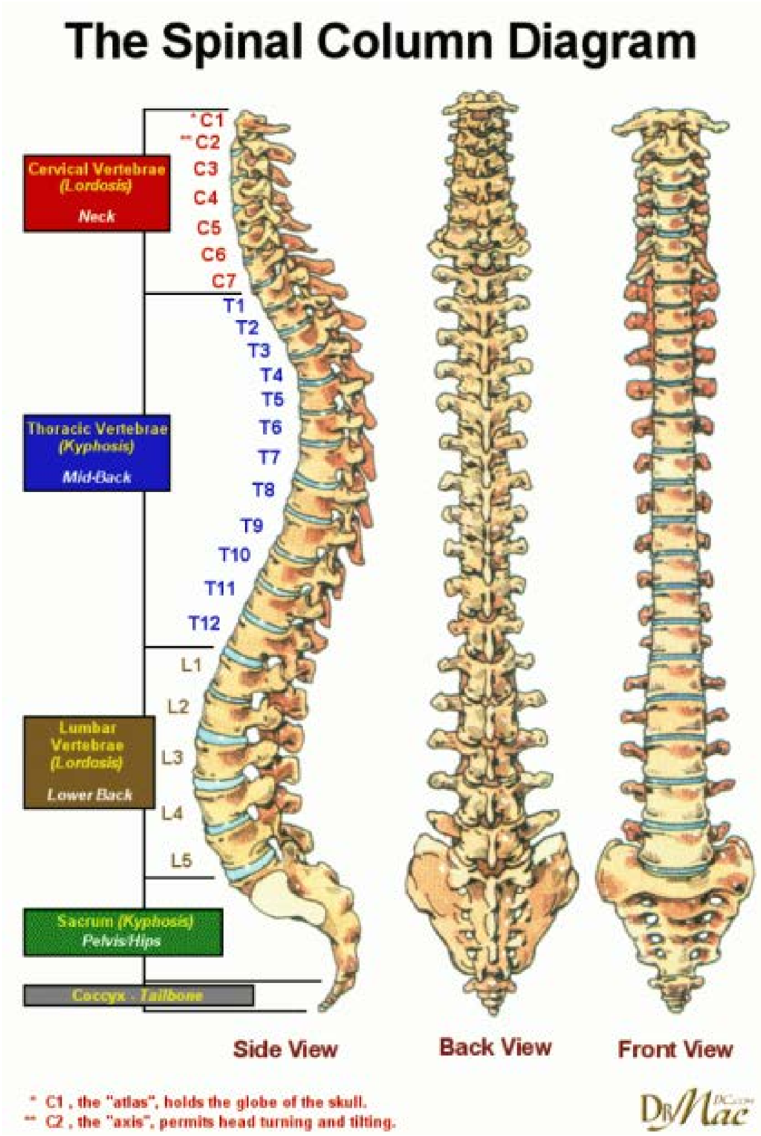
B. Spinal cord

Embryology

The development of human spine starts with the onset of the tropoblastic stage of the embryo and ends in the third decade of life[28].

The vertebral column

The vertebral column is formed from the sclerotomes of the somites.



VERTEBRAL COLUMN

Fate of Somites

The paraxial mesoderm becomes segmented to form a number of somites that lie on either side of the developing neural tube. The somite is divisible into three parts.

a. The venteromedial part is called the sclerotome which migrates medially and surrounds the neural tube to give rise to the vertebral column and ribs.

b. The lateral part is called the dermatome.

c. The intermediate part is the myotome which gives rise to striated muscles.

The cells of each sclerotome get converted into loose mesenchyme. This mesenchyme migrates medially and surrounds the notochord. The mesenchyme then extends backward on either side of the neural tube and surrounds it.

For some time the mesenchyme derived from each somite can be seen as a distinct segment. The mesenchymal cells of each segment are at first uniformly distributed. However, the cells soon become condensed in a region that runs transversely across the middle of the segment. This condensed region is called the perichordal disc. Above and below it are less condensed parts. The mesenchymal basis of the body (or centrum) of each vertebra is formed by fusion of the adjoining less condensed parts of two segments. The perichordal disc becomes the intervertebral disc.

The neural arch, the transverse processes and the costal elements are formed in the same way as the body. The Interspinous and Intertransverse ligaments are formed in the same manner as the intervertebral disc.

The notochord disappears in the region of the vertebral bodies. In the region of the intervertebral discs, the notochord becomes expanded and forms the nucleus pulposus.

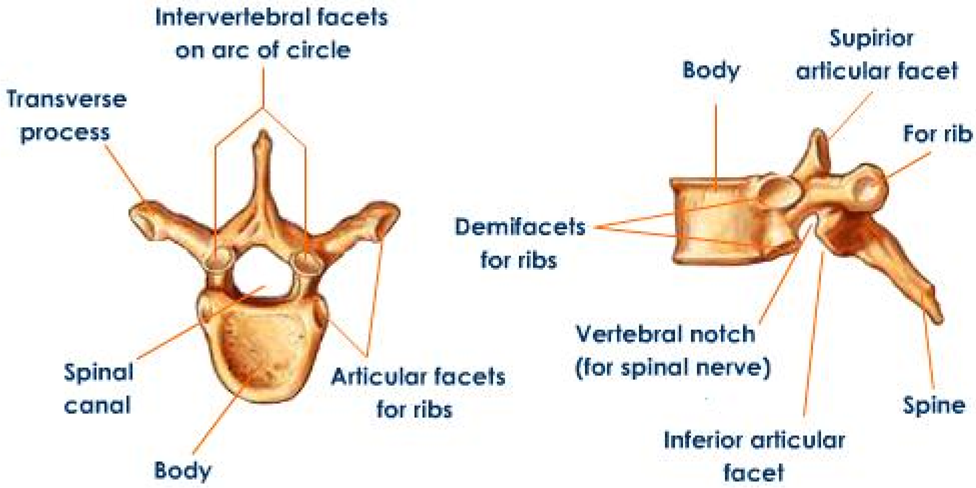
The mesenchymal basis of the vertebrae is converted into cartilage by the appearance of several centres of chondrification. Three primary centres of ossification appear for each vertebra; one for each neural arch and one for the greater part of the body (centrum). At birth the centrum and the two halves of the neural arch are joined by cartilage. Note that the posterolateral parts of the body are formed from the neural arch. The lines of junction between the parts of the body derived from the centrum and neural arches form the neurocentral joints[29].

A. Spinal column:

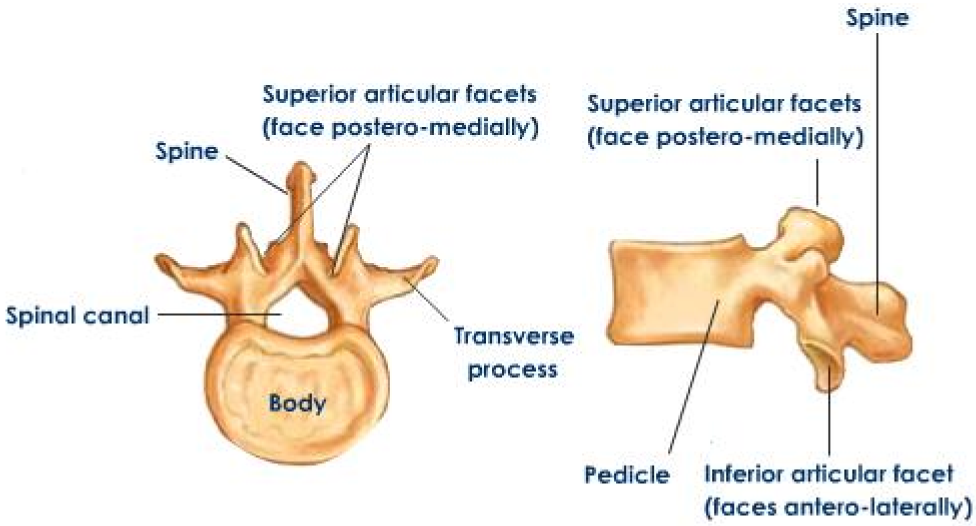
Spinal column consists of vertebral bodies and intervening discs, posterior elements (pedicles, superior and inferior articular processes, laminae, transverse processes and spinous processes) Ligaments interconnect these.

1. VERTEBRAL BODIES AND DISCS:

Thoracic spine consists of 12 vertebrae and lumbar spine 5. There is an intervetebral disc between adjoining vertebrae. Discs are firmly attached to the bodies. The anterior and posterior longitudinal ligaments give added stability. The above structures constitute the anterior and middle columns of Denis. These two columns bear 80% of the load applied to the spine in upright position.



THORACIC VERTEBRA



LUMBAR VERTEBRA

2. POSTERIOR ELEMENTS:

These consist of pedicles, superior and inferior articular processes laminae, transverse process and spinous processes. These osseous structures are connected by Supraspinous, Interspinous and Intertransverse ligaments; ligamentum flavum and facet capsules.

3. LIGAMENTS OF THE SPINE:

Ligaments are uniaxial structures; they are most effective in carrying loads along the direction in which the fibers run. They readily resist tensile forces but buckle when subjected to compression[30].The ligaments connecting the vertebrae also form a column and can be divided
as continuous and segmental.

Continuous ligaments.

_ Anterior longitudinal ligament.

_ Posterior longitudinal ligament.

_ Supraspinous ligament.

Segmental ligaments.

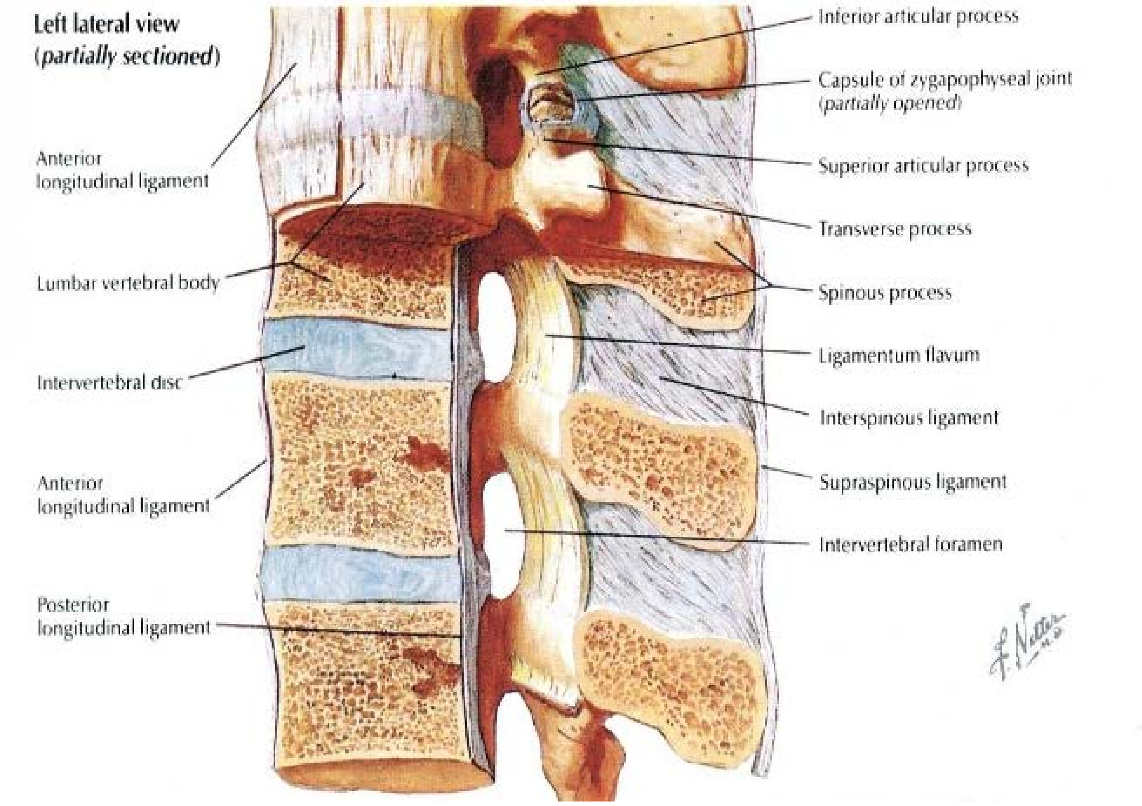
_ Ligamentum flavum.

_ Interspinous ligament.

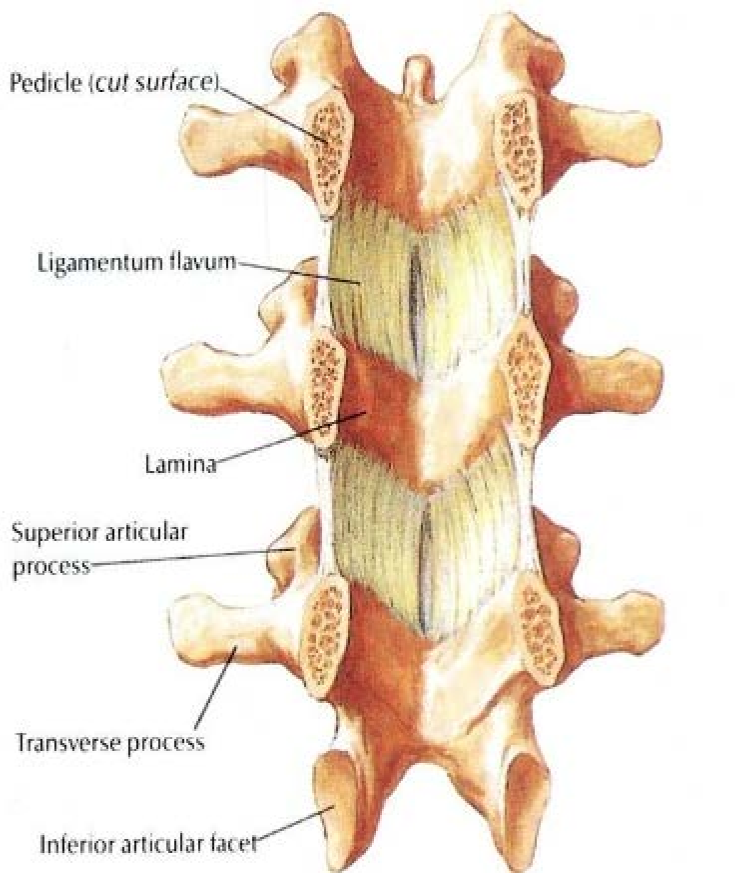
_ Intertransverse ligament.

1. Anterior longitudinal ligament: It is a fibrous structure arising from the anterior aspect of the basiocciput and is attached to the atlas and anterior surfaces of all vertebrae, down to and including a part of the sacrum.

2. **Posterior longitudinal ligament:** It arises from the posterior aspect of the basiocciput and runs over the posterior surfaces of all the vertebral bodies down to the coccyx. It is thicker in the thoracic region.



POSTEROIR VERTEBRAL SEGMENTS-LATERAL VIEW



POSTEROIR VERTEBRAL SEGMENTS-ANTERIOR VIEW

3. Intertransverse ligament: These pass between the transverse processes in the thoracic region and are characterized by rounded cords, intimately connected with the deep muscles of the back.

4. Supraspinous ligaments: This is much thicker and broader in the lumbar region and is not of much significance in the thoracic region. It originates in the ligamentum nuchae and continues along the tips of spinous processes as a round slender strand to the sacrum.

5. Ligamentum flavum: The ligamentum flavum extend from anterioinferior border of the lamina above to the posterosuperior border of the lamina below. Also called the yellow ligament (because of their high content of elastin fibres) they are thicker in the thoracic region.

6. Interspinous ligaments: They connect adjacent spinous processes and their attachments extend from root to apex of each process. They are narrow and elongated in thoracic region and broad and thick in the lumbar region.

The load bearing structures of the vertebral column are, anteriorly the body and posteriorly the two facet articulations.

4. PEDICLES :

Pedicles are the strongest part of the vertebra[31]. Anteriorly they attach to superior portion of the lateral aspect of the posterior surface of the body. Posteriorly they are attached at the pars interarticularis. It consists of outer cortical bone and inner cancellous medulla.

RELATIONSHIP TO IMPORTANT STRUCTURES[32]:

Pedicles are closely related to important structure on all sides. Knowing these structures helps the surgeon to avoid penetrating pedicle cortex during surgery.

1) Medial to pedicles are epidural space, nerve root and dural sac.

2) Caudally exiting nerve root from the same level.

3) Laterally and superiorly nerve root from the level above lies closely. At sacral level great vessels and their branches lie lateral to sacral ala.

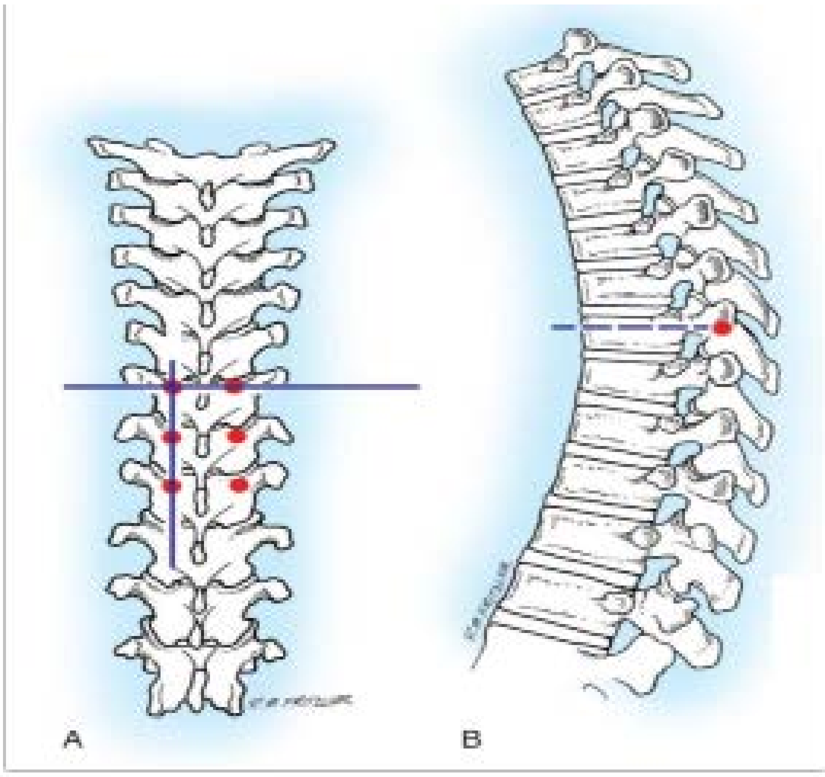
4) Anteriorly: At L3 and L4 levels, common iliac artery and veins lie directly anterior. In the sacral region variable sacral artery can lie directly anteriorly.

THREE TECHNIQUES FOR LOCALISATION OF PEDICLES[21]:

(1) **The intersection technique**: It is done by dropping a line from the lateral aspect of the facet joint.This line intersects another line that bisects the transverse process at a point overlying the pedicle

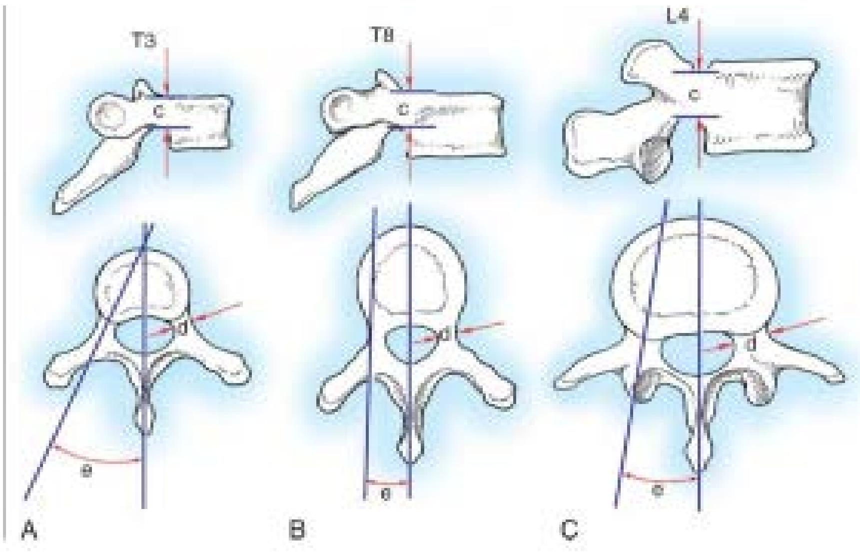
(2) **The pars interarticularis technique**: The pars interarticularis is the area of bone which connects the pedicle and the lamina. As the laminae and the pars interarticularis can be identified easily during surgery, they are used as landmarks by which an entry point can be made.

(3) **The mammillary process technique**: The mammillary process technique is done by locating a small prominence of bone at the base of the transverse process. This mammillary process can be used as an entry point for transpedicular drilling.



INTERSECTION TECHNIQUE AND MAMILLARY PROCESS

TECHNIQUE



DIRECTION OF PEDICLE SCREWS AT VARIOUS LEVELS

With pre operative CT scan, and intraoperative radiographs, the angle of the pedicle to the sagittal and horizontal planes can be determined.Pedicle dimensions vary with each vertebra. Vertical diameter (c) increases from 0.7 to 1.5 cm, horizontal diameter *(d)* increases from 0.7 to 1.6 cm with minimum of 0.5 cm in T5. Direction is almost sagittal from T4 to L4. Angle *(e)* seldom extends beyond 10 degrees.

B. SUPERIOR AND INFERIOR ARTICULAR PROCESSES AND FACET JOINTS:

Superior articular processes project upwards from the junction of lamina and pedicles. It articulates with inferior articular process of the vertebra above to from the facet joint. It is a synovial joint. The directions of the joint surfaces determine the direction of the movement possible between adjacent vertebrae.

C. LAMINAE:

These are broad plates of bone lying behind and medial to the pedicles. They fuse behind the median plane into the spinous process. They form posterior boundary of vertebral fractures.

D. SPINOUS PROCESS:

These pass backwards and downwards from the junction of the two laminae. These give attachment to ligaments and muscles which are very important in functioning and maintenance of stability of the spine.

E. TRANSVERSE PROCESSES:

These are 2 in number. They project laterally from the junction of pedicle and lamina. In the thoracic spine they articulate with ribs.

F. STRUCTURES AFFECTING STABILITY TO THE SPINE:

These are the bony architecture, the ligaments and the muscles

1. Bony structures

In the thoracic region, the rib cage stabilizes the spine. The anatomy and orientation of the articular facets lock the vertebrae well and give rotational stability.

2. Ligaments

The continuous ligaments, the segmental ligaments and capsule of facet joints all make the column stable.

3. Musculature

The paraspinal muscles absorb the tensile forces and add to the tensile strength of the posterior elements.

G. TRABECULAR PATTERN OF THE VERTEBRAE:

This has an important bearing on mechanisms of types of injury. If a vertebral body were to be cut in a coronal plane, it would be seen to consist of bony trabeculae oriented in a horizontal and vertical fashion.

If the vertebral body were to be sectioned in a sagittal plane passing through the articular processes, a special pattern of obliquely running trabeculae would be seen.

The superior trabeculae begin from the superior end plate and run posteriorly and fan out into 2 tails, one each passing to the spinous process and superior articular process. The inferior trabeculae similarly pass from the inferior end plate to the inferior articular process and the spinous process.

This arrangement of the trabeculae and hence the overlapping in the posterior half of the vertebral body makes it highly resistant to compressive forces. But this leaves a weak triangular area in the anterior half of the body which is more susceptible to axial forces. This triangle of minimum resistance fails under 600 kg of axial functional load whereas, posterior half can sustain 800 kg of axial loading.

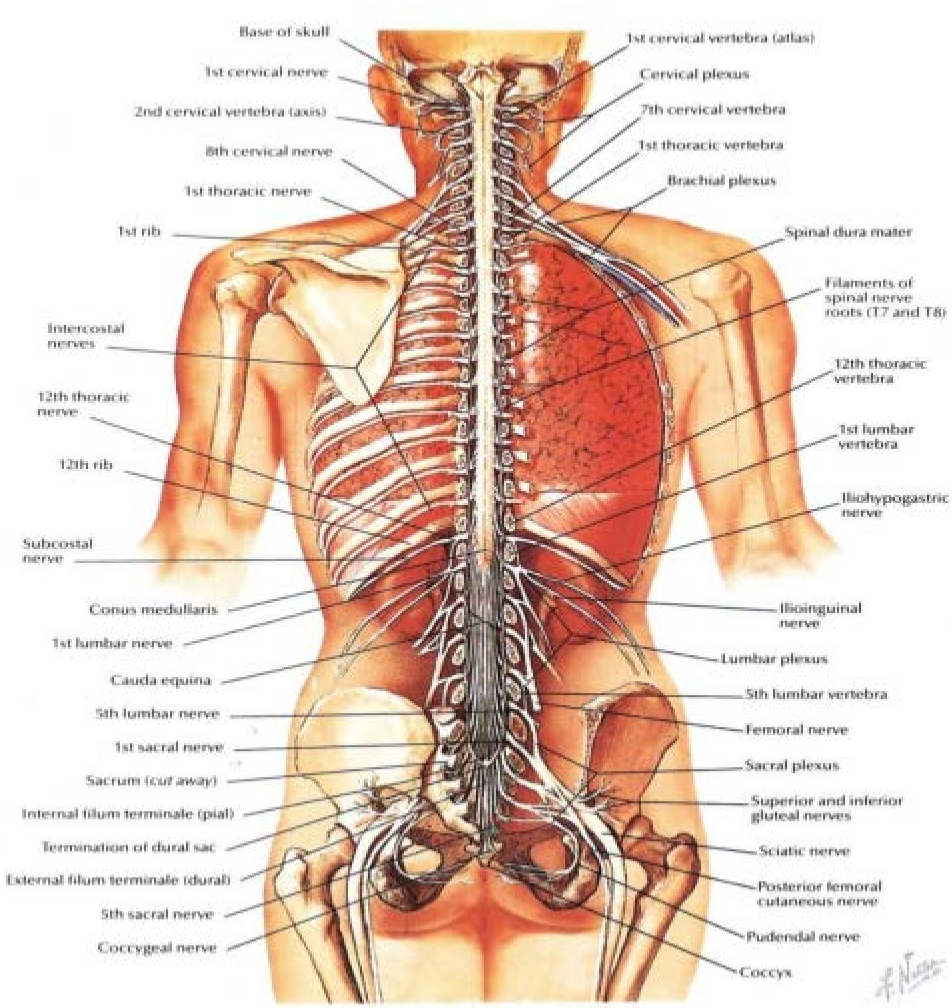
B. SPINAL CORD:

It fills about 50% of the canal in the thoracolumbar segments. The remainder of the canal is filled with Cerebro spinal fluid, epidural fat and meninges.

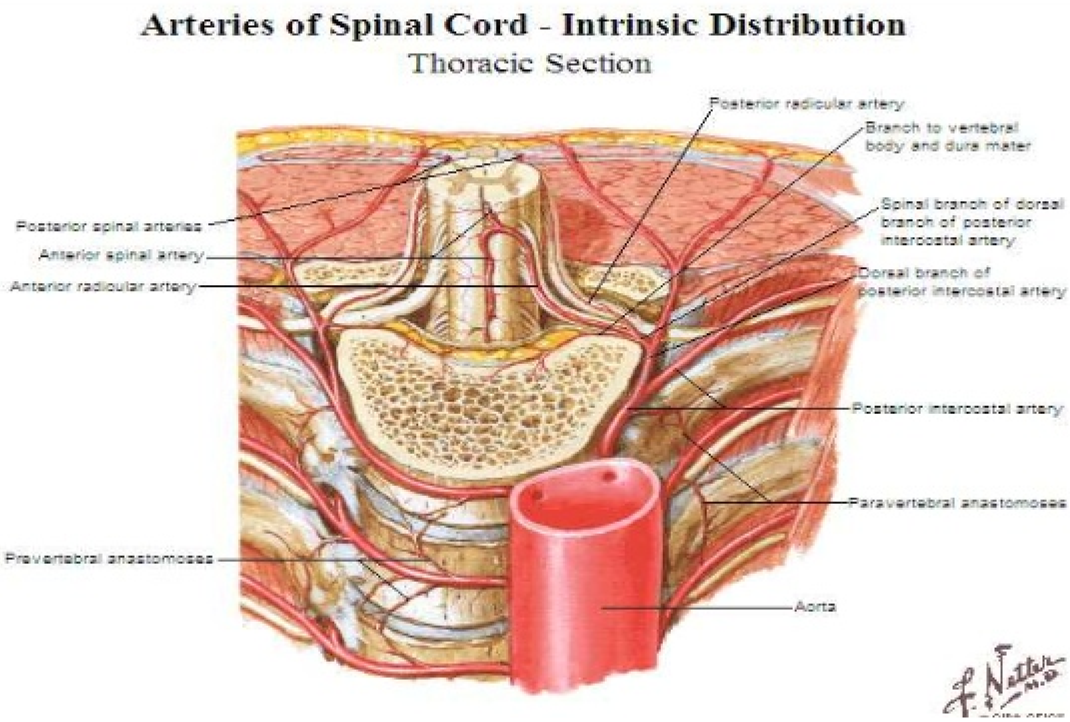
The vertebral level and the spinal cord level do not correspond to each other. From T1 to T6 the spinal cord level lies 2 levels above the vertebral body level. T7 to T9 it is 3 levels above. From T10 to T12 vertebral levels correspond to lumbar mylomeres. The conus medullaris containing the sacral and coccygeal mylomeres is dorsal to L1 and L1-2disc. Spinal cord ends at L1 L2 disc. It ends as conus medullaris. Below this cauda equina continues (motor and sensory roots of lumbosacral mylomeres). Till L1 cord trauma, root injury or both may cause the neurological deficits. Below L1, it is entirely caused by root damage.

BLOOD SUPPLY :

The blood supply of the cord is precarious. The arterial supply consists of the posterior spinal arteries and a single anterior one. The two posterior spinal arteries originate from branches of the posterior inferior cerebellar arteries and run the length of the cord, lying on its posterior surface and supply the posterior and periphery of lateral portion of the cord. The anterior spinal artery originates from a fusion of branches from the vertebral artery, and runs the length of the spinal cord lying in the anterior longitudinal fissure, it supplies the anterior and central portion of the cord. In the thoracic and lumbar region of spine, spinal branches of the lumbar segmental arteries pass through the respective intervertebral foramina, and divide into posterior and anterior radicular branches which contribute to the posterior and anterior spinal artery respectively. These spinal branches are not constant and do not enter the cord at every segmental level. An abundant segmental contribution usually enters at the upper thoracic level often at T4. Additional anastomosing vessels to spinal artery flow at or near the thoracolumbar junction entering most often at the T10 or T11 level on the left side. The segmental anterior radicular branch entering at this level is frequently called the great radicular medullary artery, or the artery of ADAMKIEWEIZ.



SPINAL CORD



BLOOD SUPPLY OF THE SPINAL CORD

BIO MECHANICS

Bio-mechanics should be considered in terms of Kinematics i.e., the physiologic motion allowed with the constraints of anatomy and the forces acting on the spine.

Any motion of the spine may be resolved into 6 components using a three dimensional co-ordinate system. The three pure types of translation along a single axis are anteroposterior translation along sagittal plane (along Z axis). Mediolateral translation in the frontal plane (along x axis), and Craniocaudal translation along longitudinal plane (along Y axis).

Angular motion can also be described by the coordinate system. The three pure types of angulations are flexion extension in the sagittal plane (x is the axis of rotation), lateral flexion in the frontal plane (z is the axis of the rotation) and rotations about the craniocaudal axis (y is the axis of rotation). The six cardinal motions (3 linear and 3 angular) can be coupled.

Motions of translation are relatively restricted in the thoracolumbar spine, especially anteroposterior or mediolateral translation. Consequently physiologic motion of the spine is achieved chiefly by angulations.

Thoracic spine is much stiffer than the lumbar spine in sagittal plane. This restricts lateral flexion-extension. This is due to restraining effects of the rib cage, and the relatively thinner discs of the thoracic spine, which restrict the arc of motion[33].Rotation about the craniocaudal axis is greater in the thorac spine[34]. In the lumbar spine, rotation is limited by the orientation of the facets and the anterior portion of the annulus to only 10 degrees for the entire lumbar spine versus about 75 degrees of rotation of each side in the thoracic spine[35].

Forces:

The forces acting on the spinal column include internal (i.e. muscle) forces and external forces resulting from contact with the environment (e.g. gravity,acceleration or missile). Kelly[36] and Whitesides observed that the vertebral bodies and discs primarily function to support compressive loads, whereas the processes, with their profusion of connecting ligaments seem best adapted to withstand tensile forces.

Jacobs et al[37] analyzed the normal physiological forces acting on the spine. Thoracolumbar junction transmits a compressive load of approximately 400 Newton's owing to the weight of the body above that point. Because the centre of gravity is located anterior to the spine, this eccentric position results in a flexion. Bending forwards to 90 degrees at the hips, results in 400 N shear forces between the two vertebrae in addition the flexion bending movement increases the shear force dramatically to 120NM. Treatment should restore the ability of the vertebral column to withstand these physiological stresses. Haher[38] and co-workers analyzed the load-carrying capacity at thoracolumbar junction. By disrupting the anterior column, they found that the load-carrying capacity of the thoracolumbar junction decreased by 30%. Ablating the anterior and middle columns decreased the load carrying capacity by 70%. Ablating posterior column decreased the capacity by 65 %. By ablating annulus, rotatory stability diminished by 80%. This helps us evaluate the instability more accurately.

Degenerative spine disease usually presenting with low back pain are associated with increased translation movements in sagittal plane associated with rotation. In cases of burst fractures thoracolumbar spine is quite unstable in axial rotation . Haher et al (7) implicated that disruption of the anterior column results in rotational instability.

CLASSIFICATION

Classification of Thoracolumbar Fractures

Various classification systems are available for classifying thoracolumbar fracture including Nicoll classification[39] who classified these fractures into stable or unstable patterns.

Holdsworth's classification - He modified and expanded Nicoll's classification and classified the spine into two columns.The vertebral body,discs and associated ligaments form the anterior column and all other structures come under posterior column.

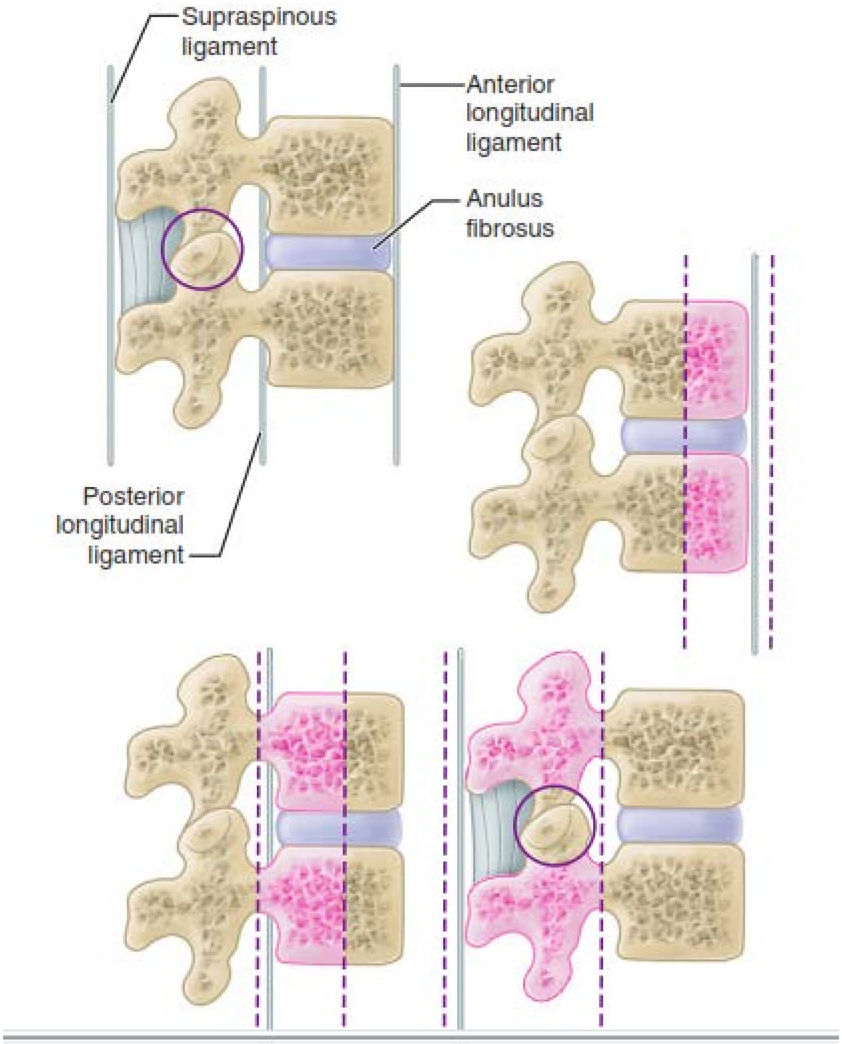
Denis's three-column concept :

The anterior column-consists of anterior longitudinal ligament, anterior half of the vertebral body, and anterior portion of the annulus fibrosus.

The middle column consists of the posterior longitudinal ligament, posterior half of the vertebral body, and posterior aspect of the anulus fibrosus.

The posterior column- neural arch, the ligamentum flavum, facet capsules, and the interspinous ligaments.

Denis noted that one or more of the three columns predictably failed in axial compression, axial distraction, or translation from combinations of forces in different planes.



DENIS THREE COLUMN CLASSIFICATION

DENIS CLASSIFICATION: It consists of five types.

(1) **Pure flexion-** stable wedge compression fracture

(2) **Flexion and rotation injury-** unstable fracture-dislocation with rupture of posterior ligament complex,with separation of spinous processes,and a slice fracture near upper border of lower vertebra, with dislocation of lower articular processes of the vertebra above the injury.

(3) **Extension injury-** rupture of the intervertebral disc and the anterior longitudinal ligament and avulsion of a small bone fragment from the anterior border of the dislocated vertebra.

(4)l **Compression fracture**- This is a fracture of the end plate as the nucleus of the intervertebral disc is forced into the intervertebral body, causing it to burst, with outward displacement of fragments of the body.This comminuted fracture is stable as the ligaments are intact.

(5) **Shear injury-** an unstable fracture of the articular processes or pedicles which results in displacement of the whole vertebra .

This classification system does not consider the “unstable burst fracture” described by McAfee et al[39].

Kelly and Whitesides classification[40]- thoracolumbar spine as consists of two weight bearing columns. 1.hollowcolumn - spinal canal, 2.solid column-vertebral body.

McAfee et al[39]. classified thoracolumbar injuries based on the mechanisms of failure of the middle osseoligamentous complex.

1) **Wedge compression fractures-** failure of the anterior column due to forward flexion.Middle and posterior columns are intact.It is a stable fracture.

2) **Stable burst fractures-** The anterior and middle columns fail due to a compressive force, with intact posterior column.

3) **Unstable burst fractures-** the anterior and middle columns fail in compression,with disruption of the posterior column.

4) **Chance fractures-** avulsion fractures of the vertebral bodies in the horizontal plane.This is due to flexion around an axis anterior to the anterior longitudinal ligament. The entire vertebra is pulled apart by a strong tensile force.

5) **Flexion distraction injuries-**In this type of injury,the axis of flexion is posterior to the anterior longitudinal ligament. The anterior column fail in compression,and the middle and posterior columns fails in tension. This injury is unstable as the posterior elements are disrupted.

6) **Translational injuries**- these are characterized by malalignment of the neural canal, which has been totally disrupted. These injuries are associated with failure of all the three columns in shear.

AO CLASSIFICATION[40]:

Injuries into three groups based on the primary mechanism of failure.

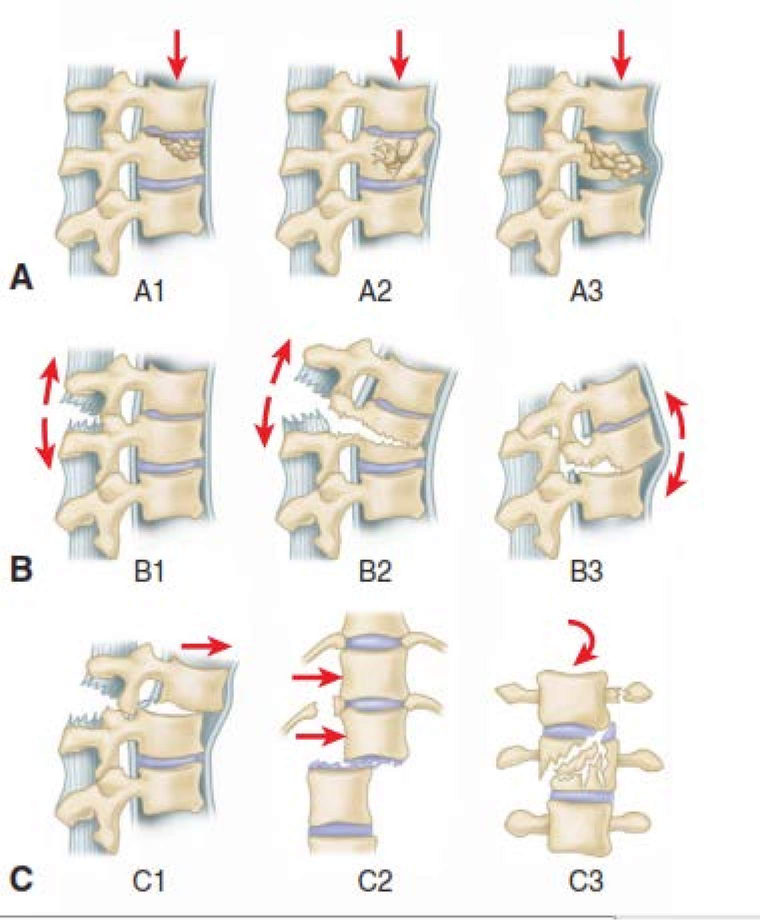
A- compression

B-distraction

C-rotation

Group A injuries result primarily from axial or compressive loads, with or without flexion, with limited involvement of the posterior elements. With greater forces, there may be significant height loss, and vertebral body fragments can be retropulsed into the spinal canal in neurologic compromise. Group B injuries are the result of distraction forces and are unstable.

Group C, or rotational injuries, also imply gross ligamentous injury. These injuries are often associated with transverse process fractures, costovertebral dislocations, translational malalignment between vertebral bodies, and frequently, neurologic deficit.



AO CLASSIFICATION: A-compression injuries,B-distraction injuries, C-translational and rotational injuries

LOAD SHARING CLASSIFICATION:

McCormack et al defined a classification scheme specifically intended to predict when a short-based construct would fail. Named the Load-Sharing Classification, it assigned a point value to the degree of vertebral body comminution, fracture fragment apposition, and kyphosis[40].

Based on their primary outcome of hardware failure, McCormack et al concluded that injuries with scores greater than 6 points would be better treated with the addition of anterior column reconstruction. A recent study demonstrated very high inter and intraobserver reliability of this classification system.

THORACOLUMBAR INJURY CLASSIFICATION AND SEVERITY SCORE:

The **TLICS**[41] system incorporates the neurological function of the patient, which is very important in determining of functional outcome for a patient with spine injury. The reliability of the system has been found to be equivalent to other systems, but the validity of the criteria has not been demonstrated.

FRACTURE MECHANISM	POINTS
Compression fracture	1
Burst fracture	1
Translation/rotation	3

Distraction	4

NEUROLOGICAL INVOLVEMENT

Intact	0
Nerve root	2
Cord, conus medullaris, incomplete	3
Cord, conus medullaris, complete	2
Cauda equine	3

POSTERIOR LIGAMENTOUS COMPLEX INTEGRITY

Intact	0
Injury suspected/indeterminate	2
Injured	3

POINTS :

3points- non operative management

5 points-operative management

4 points-operative or non operative depending upon comorbid conditions and other injuries.

SURGICAL MANAGEMENT:

The goals of surgical treatment include restoring alignment, correcting deformity, decompressing neural structures and achieving stable spinal column. Surgical treatment offers significant advantages in select cases.

1. It restores sagittal plane alignment, corrects translation and decompresses the neural structures.
2. Operative management may facilitate neurological improvement.
3. It may decrease rehabilitation time compared to recumbent treatment.
4. Fusion with instrumentation gives stable spine construct.

Surgical decompression:

This is commonly done by posterior or by anterior decompression. The aim of the surgery is to decompress the spinal cord and give it a better chance for neurological recovery.

Indications:

1. Demonstrable neural compression and worsening neurological deficit.
2. Demonstrable neural compression and myelopathy, especially worsening.
3. Demonstrable neural compression and persistent or worsening radicular symptoms (relative).

SURGICAL STABILISATION:

Indications:

_ All cases requiring surgical decompression.

_ Disruption of the posterior ligamentous complex.

_ Dislocation of the thoracolumbar and lumbar spine.

_ Compression fractures with loss of greater than 50% of the vertebral body height or angulations greater than 20 degrees.

_ Severe degenerative disease with gross segmental instability.

_ Gross infective or tumors involvement of vertebrae leading to instability.

_ Traumatic spondylolisthesis.

_ Post operative instability.

_ Malalignment that cannot be corrected and maintained long term by non-surgical measures e.g. lumbar lordosis.

_ Cosmetically unacceptable deformity (relative).

_ Intolerance of non operative management.

_ Failure of non operative management (new neurological symptoms or signs, instability, increasing pain, increasing or unacceptable deformity).

APPROACHES:

Successful spinal instrumentation depends significantly on the technique of surgical exposure and fusion.. Different approaches for decompression and stabilization of spine are:

1. Posterior approach:

The main advantage of this approach is posterior instrumentation gives good stability and high fusion rates when compared to anterior instrumentation. Dissection is safe and no important structures are at danger unlike anterior approach.

2. Anterior approach:

Most of the pathology in spinal trauma leading to neurological damage is anterior to the cord. Anterior approach is ideal for exploration in these patients. Vertebral body damage is better visualized and so adequate decompression can be done. It allows for the direct attack on the pathology. The main disadvantage is unfamiliarity of Orthopaedic surgeons to this approach. So this is technically demanding.

This approach consists of transthoracic, transabdominal, retroperitoneal or combination of these. Generally, corpectomy is done to expose the posterior longitudinal ligaments. This is incised to expose the cord. Thorough decompression is done. Generous corticocancellous strut grafts are put and anterior or /and posterior instrumentation is done.

3. Lateral extracavitary approach:

This is the extension of costotransvectomy approach. Capener originally described it. Larson et al combined it with the transpedicular approach on the contralateral side.

4. Combined approaches:

Most commonly anterior and posterior approaches are combined. The decompression and strut grafting is done anteriorly followed by posterior instrumentation

Internal fixation devices:

Spinal instrumentation has evolved far beyond the original Harrington design with increasing complexity and capabilities.

Pedicle implants:

- Roy Camille
- Whitse
- Dynalock
- Steffee
- Luque
- Moss miami system.

POSTERIOR INSTRUMENTATION:

Advantage of posterior approach:

1. Long segment fixation is easier.
2. Does not compromise lung function, which may already be compromised after injury.
3. Fracture reduction where necessary is easier.
4. Familiar approach to most orthopedic surgeons.
5. Complication rates are low.

Pedicle screw instrumentation:

Advantages:

a. Short, rigid immobilization.

b. High fusion rates.

c. Early mobilization.

d. Low percentage of hardware failure.

e. Maintains curvature of spine.

Disadvantages:

a. Increased degenerative changes in motion segment above and below the level of instrumentation.

b. Fatigue failure.

c. Screw loosening.

d. Spinal cord injury.

e. Vascular injury – aorta, inferior venacava and their branches.

f.Potential for recurrence of deformity after lumbar burst fractures because of lack of anterior support.

Pedicle screw instrumentation is now widely used among spinal surgeons. Pedicle screws have the ability to manipulate all three columns of the spinal column from a posterior approach. Much debate still exists as to their proper application and placement to achieve the ultimate clinical outcome. Because of the force that can be generated while utilizing these devices, normal contours can be changed, and problems such as iatrogenic flat back are being encountered.

The pedicle screw is the stiffest construct available today and appears to have the highest fusion rates. In addition, its stiffness allows for shorter fusion segments to maintain stability. The pedicle screw can be utilized with plate-and-rod constructs as well as with hook combinations. The anatomy of the pedicle varies from 4.5 mm at T-4 to 15 mm at L-5 with the inner diameter being approximately 80% of the total, In the thoracic spine the angle of the pedicle, posterolateral to anteromedial was 13.9 degrees at the fourth thoracic vertebra and 0.3 degrees at the 12th thoracic vertebra.

The lumbar pedicles roughly advance from posterolateral to anteromedial at 5 degrees a level. General placement of pedicle screws is 5 degrees at L-l, 10 degrees at L-2, 15 degrees at L-3, 20 degrees at L-4, and 25 degrees at L-5.

Though averages in pedicle inclination are helpful references, CT, MRI, and x-rays should always be looked at be fore operative pedicular screw placement. Specific inclination and pedicle width anomalies can be identified and appropriate action taken to successfully place the pedicle screw.

The entrance points and directions are debatable. Generally the entrance point is crossed by the line that connects the middle of the transverse processes and the lateral edge of the facet. In the thoracic spine, the entrance point is in line with the middle of the transverse process, which is about 2 mm below the inferior edge of the facet. The thoracic pedicle entry point is also crossed by the vertical line that connects the middle of the facet joint. The benefits of angling the screw from lateral to medial are threefold. First, a lateral starting point decreases the potential contact with the superior facet joint, which is not involved in the fusion mass. Second, a lateral-to-medial angulation allows for the placement of a longer overall pedicle screw. This improves overall pullout strength. The third benefit of a lateral-to-medial angulation is the interlocking effect that occurs between the right and the left screws. This locking effect improves the strength of the construct in resisting torsional and late kyphosis.

Pedicle screw outer diameter is most important to pullout strength, though bone mineral density can also affect pullout strength. In trauma patients, lumbar fractures can be treated with pedicle screws one level above and below because the size of the pedicle and the size of the screw can usually stabilize the fracture while it heals.

Tapping is not necessary but may be done with a smaller tap. After tapping is completed, the bone is generally decorticated, and bone graft is placed before the final placement of the screws. Pedicle screw insertion should be performed utilizing the largest possible screw diameter that can safely be placed in the pedicle as measured on the inner diameter. The screw should obtain a depth of approximately 80% of the vertebral body as measured from CT or radiographs. Screws should be placed parallel to the end- plates or slightly cephalad angulation. Care should be taken not to injure or impinge facets not involved in the fusion.

DIFFERENTIAL DIAGNOSIS :

Traumatic fracture or dislocation of thoracolumbar spine is rarely diagnostic problem. However, a few congenital and a few acquired conditions can mimic reoentgenographic appearance of these injuries.

1. A DIMINITIVE LUMBAR RIB: May be mistaken for a transverse process fracture. This congenital variant is almost always limited to the first lumbar segment and may be bilateral. The rib and transverse process have a smooth, rounded contour, close inspection may reveal a well developed costotransverse articulation. By contrast a true transverse process fracture is usually multiple and occurs at lower lumbar levels and is almost always unilateral. The fracture surfaces have a jagged appearance.

2. CONGENITAL KYPHOSIS: This when particularly associated with total or partial absence of vertebral body, does closely resemble the roentgenographs appearance of an anterior wedge vertebral body fracture. The tendency for these anomalies to occur at the thoracolumbar junction makes it even more likely for them to be confused with a post traumatic deformity. Differentiation between traumatic and congenital deformity may have to depend upon details of the history and clinical examination because in some cases there is no certain way to make the distinction by roentgenograph criteria.

3. HEMIVERTEBRA: This can be confused with a lateral bending vertebral body fracture. However, this congenital anomaly is always associated with unilateral absence of a pedicle. This is never seen in lateral wedge fracture of the vertebral body

4. SCHEURMANNS DISESE: (JUVENILE VERTEBRAL APOPHYSITIS): Scheurmanns disease and mild form of spondylo eiphyseal dysplasia may be confused with anterior wedge fracture of the thoracic vertebral bodies. This condition can be distinguished from post traumatic deformity, because unlike in trauma, tie edge deformity is usually present at several levels and is associated with marked narrowing of the intervening disc.

5. SPONDYLOLISTHESIS: Spondylolisthesis or spondylolysis is seldom the result of a single traumatic episode. It is almost always located at L5 and may or may not be associated with backache. The x ray appearance of the pars interarticularis defect is smooth and does not suggest an acute fracture. True traumatic spondylolysis is very rare, and tends to occur at mid or upper lumbar levels. The pars defect shows the jagged irregularity,characteristic of an acute fracture.

MATERIALS AND METHODS

In all, a total of 20 cases were evaluated and assessed during the study period between August 2012 and July 2014 . The study was conducted in the Department of Orthopaedics, GMKMCH,SALEM.

All the above patients underwent treatment, as per a specific treatment plan.

All the patients were initially assessed in the casuality according to their presentation and then they underwent a detailed evaluation of their hemodynamics, spine, neurological status and other injuries if associated with trauma. The patients were interviewed; their epidemiological, historical, subjective and physical findings were noted.

After initial investigations and haemodynamic stabilization, patients were assessed neurologically in detail. A neurological chart was maintained for each patient.

All the patients had routine X-rays of thoracolumbar and lumbar spine in both Anteroposterior and Lateral views. In all the patients MRI with CT films was done . The pre-operative neurological status was graded on the basis of **ASIA** grading. It was also used to assess post operative recovery and follow-up. The indication for the surgery was instability for which instrumentation was needed to restore spinal stability or to protect neurological elements.

Inclusion criteria:

1. Age group >14 years

2. Traumatic thoracolumbar fractures T11-L2.

3. Unstable fractures with or without neurological deficits.

4.Kyphotic angle > 30 degrees

5.Loss of vertebral body height more than 50%

6. Spinal canal compromise > 50%

7. TLICS score >4.

Exclusion criteria:

1. Age < 14 years

2. Traumatic cervical spine fractures and sacral spinal fracture.

3. Spinal instability due to congenital spinal abnormality.

4. Patients not willing for surgery.

5. Medically unfit for surgery.

6.Multiple level fractures. .

PREOPERATIVE WORK UP :

NEUROLOGICAL ASSESSMENT:

In thoracic and lumbar spinal lesions it is important to determine the level and extent i.e. Complete or incomplete, neurological injury. In case of trauma the most important step is to establish level of consciousness. Glasgow coma scale is universally accepted method for determining this[42]. Spinal shock, if present it rarely lasts longer than 24 hours, but might last for days or weeks exceptionally. A positive bulbocavernous reflex or return of anal wink reflex indicates the end of spinal shock. An initial examination should include a detailed sensory examination, motor examination and reflex functions. Sacral sensory sparing is an important evidence of incomplete neurological injury.

The most widely accepted classification for categorizing patients with neurological injury is the one proposed by American spinal injury association (ASIA) impairment scale.

ASIA Scale[43]:

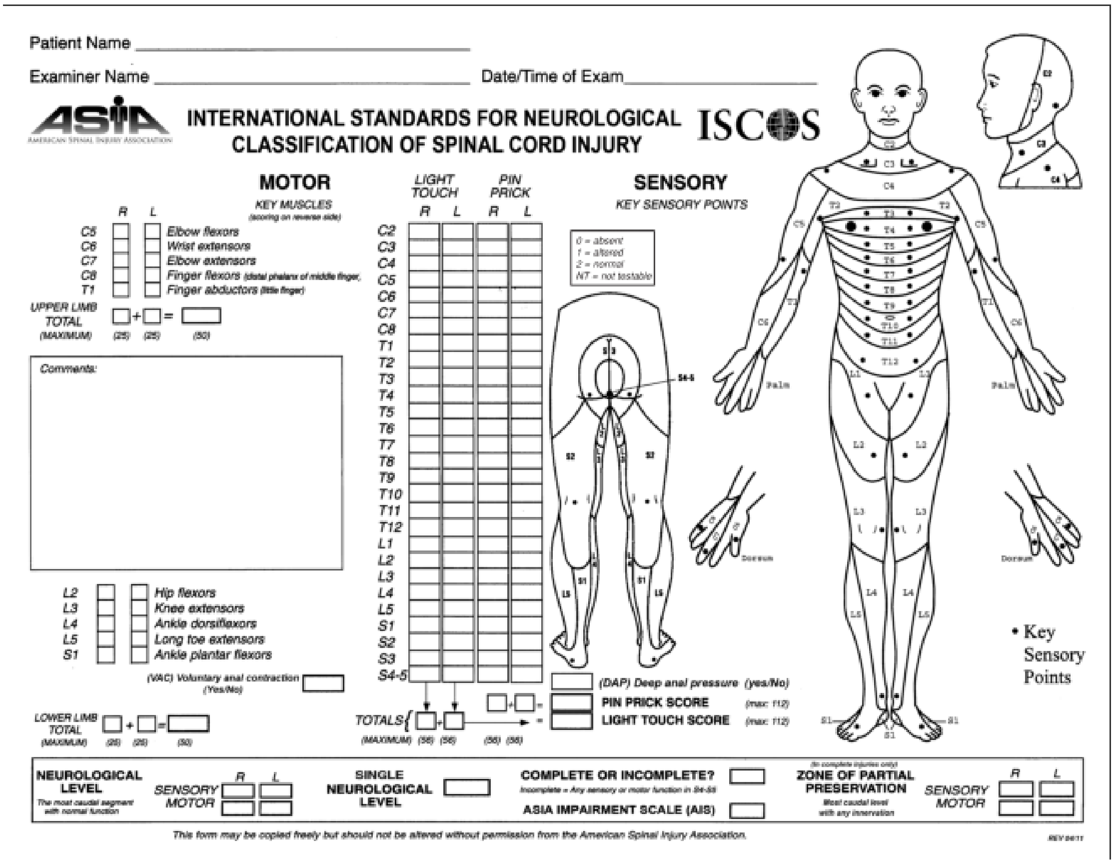
Grade A: Absent motor (Grade 0/5) and sensory function below the injury level.

Grade B: Sensation present, motor function absent (grade 0/5).

Grade C: Sensation present, motor function active but not useful (grade 1 to 2/5).

Grade D: Sensation present, motor function active and useful (grade 3 to 4/5).

Grade E: Normal motor (Grade 5/5) and sensation function.


Patient Name ____________________

Examiner Name ____________________ Date/Time of Exam ____________________

ASIA AMERICAN SPINAL INJURY ASSOCIATION

INTERNATIONAL STANDARDS FOR NEUROLOGICAL CLASSIFICATION OF SPINAL CORD INJURY

ISCOS

MOTOR KEY MUSCLES (scoring on reverse side) R L

C5 Elbow flexors
C6 Wrist extensors
C7 Elbow extensors
C8 Finger flexors (distal phalanx of middle finger)
T1 Finger abductors (little finger)

UPPER LIMB TOTAL (MAXIMUM) (25) (25) (50)

Comments:

L2 Hip flexors
L3 Knee extensors
L4 Ankle dorsiflexors
L5 Long toe extensors
S1 Ankle plantar flexors

(VAC) Voluntary anal contraction (Yes/No)

LOWER LIMB TOTAL (MAXIMUM) (25) (25) (50)

LIGHT TOUCH R L PIN PRICK R L

C2 C3 C4 C5 C6 C7 C8 T1 T2 T3 T4 T5 T6 T7 T8 T9 T10 T11 T12 L1 L2 L3 L4 L5 S1 S2 S3 S4-5

TOTALS (MAXIMUM) (56) (56) (56) (56)

SENSORY KEY SENSORY POINTS

0 = absent
1 = altered
2 = normal
NT = not testable

(DAP) Deep anal pressure (Yes/No)

PIN PRICK SCORE (max: 112)

LIGHT TOUCH SCORE (max: 112)

• Key Sensory Points

NEUROLOGICAL LEVEL The most caudal segment with normal function SENSORY MOTOR R L

SINGLE NEUROLOGICAL LEVEL

COMPLETE OR INCOMPLETE? Incomplete = Any sensory or motor function in S4-S5

ASIA IMPAIRMENT SCALE (AIS)

ZONE OF PARTIAL PRESERVATION (In complete injuries only) Most caudal level with any innervation SENSORY MOTOR R L

This form may be copied freely but should not be altered without permission from the American Spinal Injury Association.

ASIA SCALE

INVESTIGATIONS:

1. Plain radiograph (static and dynamic wherever necessary)

   i. Anteroposterior views.

   ii. Lateral views.

To assess extent of degeneration, instability, mechanism of injury, fracture pattern and its severity and canal compromise or deformity.

2. Magnetic resonance imaging (MRI) was useful in determining

   i. The condition of the spinal cord following trauma

   ii. Any soft tissue encroachment (intervertebral disc) of the spinal cord

3. CT scan- to assess pedicle fractures , canal compromise and retropulsion of vertebral body.

4. Blood investigations- complete blood count , blood sugar, urea, creatinine, serum electrolytes, ELISA for HIV virus and Blood grouping were done.

5. Chest X-ray and ECG were routinely taken to rule out cardiac and pulmonary pathology.

6. Adequate blood was reserved for surgery.

7. Taylor's brace was applied to immobilize the spine and patients were kept in strict bed rest.

INSTRUMENTS:

GENERAL INSTRUMENTS:

1.Morris self retaining retractor

2.Cobbs elevator

3.Pedicle Awl

4.Pedicle Probe

5.Ball tipped Sound

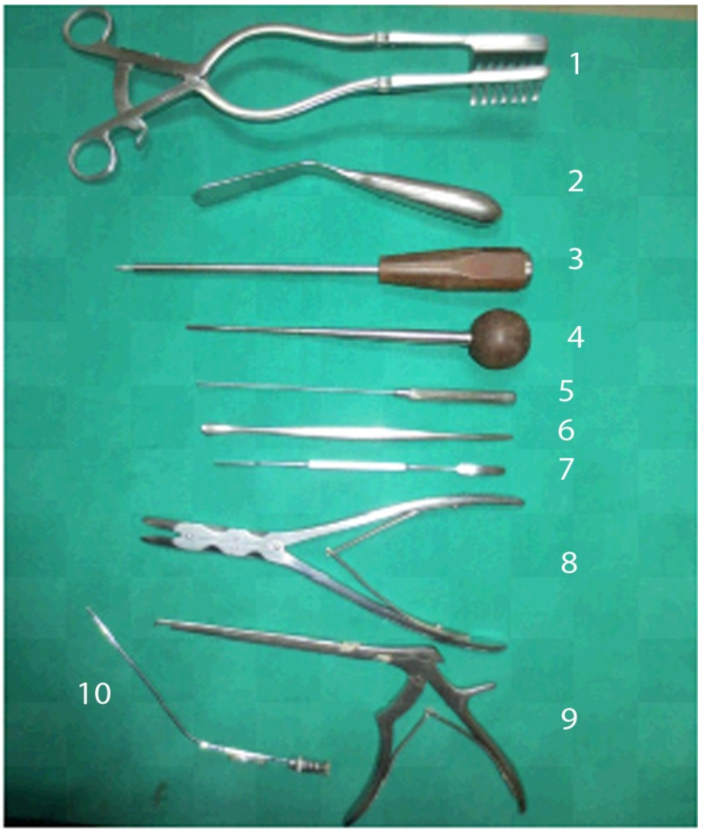
6.Laminar spreader

7.Dural retractor

8.Nibbler

9.Up cutter

10.Suction tip



GENERAL INSTRUMENTS

SPECIAL INSTRUMENTS:

1.Distractor

2.Contractor

3.Rod stabiliser

4.Rod bender

5.5mm tap

6.6mm tap

7.Rod holder

8.Rod pusher

9.Poly axial screw driver

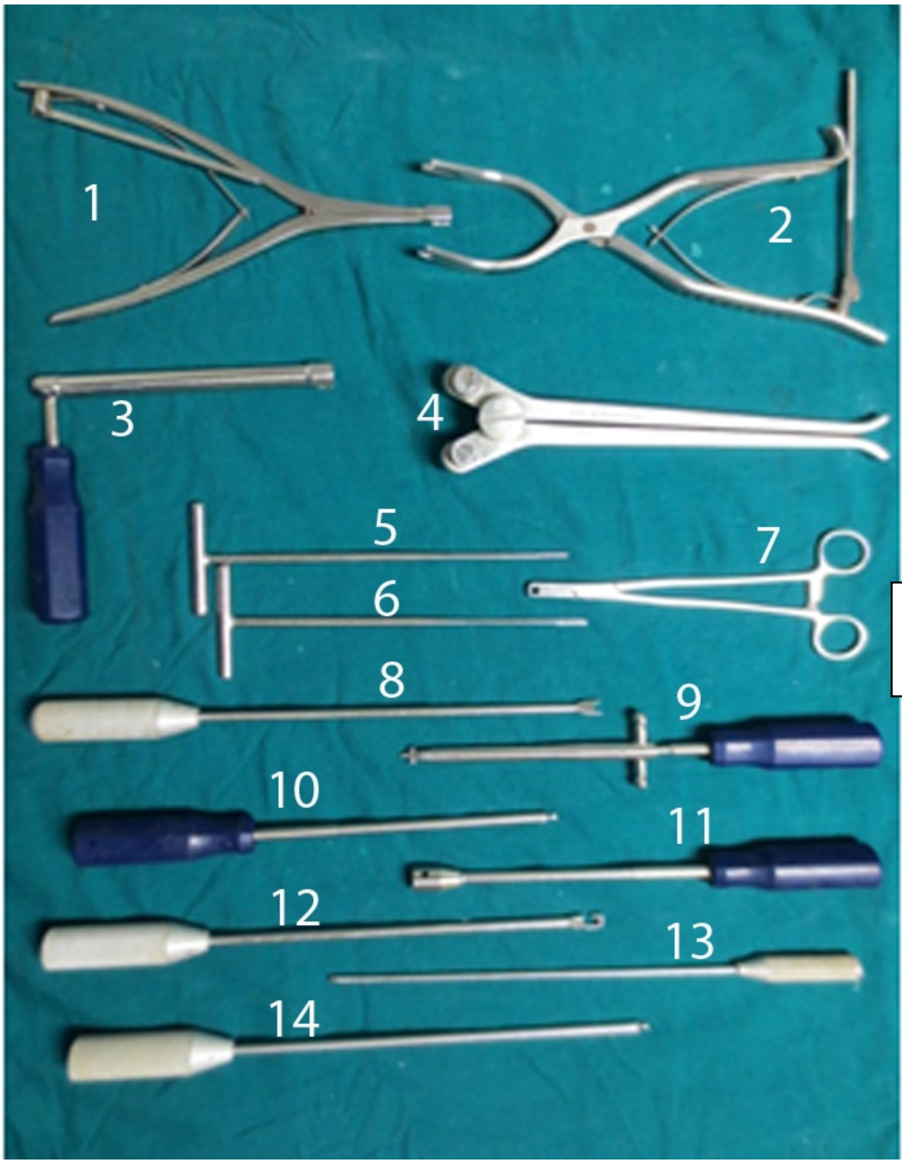
10.Poly screw tightner cum remover

11 Mono axial screw driver.

12.Rod puller

13.Inner screw inserter

14.Inner screw tightner



SPECIAL INSTRUMENTS

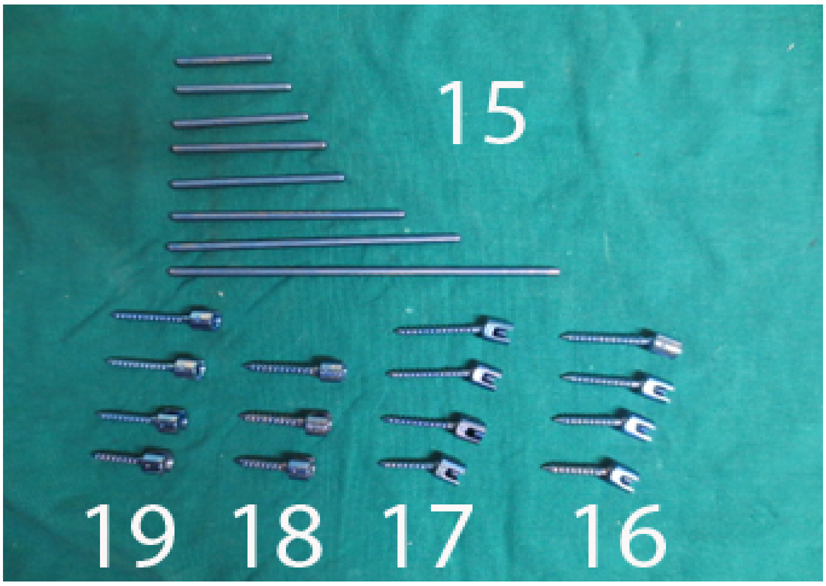
15.Titanium rod

16.6mm poly screws

17.5mm poly screws

18.6mm mono screws

19.5mm mono screws



PEDICLE SCREWS AND RODS

Procedure- :

Prophylactic intravenous antibiotics were given preoperatively. In supine position general anaesthesia with endotracheal intubation was administered.

POSITION:

The patient was put in prone position on a 4 poster frame encouraging more lordosis. Care was taken to keep the nipples in females and the scrotum in males from free from pressure. This position avoids venous stasis and decreases intra abdominal pressure, thus reducing venous bleeding. All bony prominences were padded. The skin, subcutaneous tissues, and paraspinal muscles down to the level of lamina were infiltrated with 1:50000 epinephrine solution to minimize bleeding.

APPROACH:

A posterior midline incision was made centering over the involved spinal unit and extending 2 levels above and below.Incision was deepened to the tips of the spinous processes. Using Cobbs elevators the paraspinal muscles were erased laterally to the tips of the transverse processes. Packing with a pad was done to reduce bleeding.

ENTRY POINT:

The intersection technique was used to locate the entry point .It is crossed by the line that connects the middle of the transverse processes and the lateral edge of the facet. In the thoracic spine, the entrance point is in line with the middle of the transverse process, which is about 2 mm below the inferior edge of the facet.

C-ARM:

C-arm was used to identify the upper level to be instrumented. The beam was adjusted until the pedicle is visualized on end just below the superior end plate. A nibbler was used to decorticate the bone over the lateral side of the pedicle Pedicle awl was inserted into the pedicle, and advanced through the pedicle.A probe was inserted in the path of the awl and the path of the probe was monitored with posteroanterior and lateral C-arm images.The probe was removed after the vertebral body is entered. The continuity of the pedicle wall was conformed with a small ball-tipped probe in superior , inferior, medial and lateral walls and that violation into the spinal canal or inferiorly into the neural foramen has not occurred.

INSERTION OF PEDICLE SCREWS:

The pedicle and vertebral body was tapped to at least one half of the depth of the vertebral body using a tap for a screw diameter chosen from preoperative pedicle measurements.The size of the tap was the same as the size of the pedicle screw to be inserted.5mm screws were used for thoracic vertebrae and 6 mm screws were used for lumbar vertebrae.

The direction of insertion of pedicle screw was monitored with C-arm .It was straight in lateral view and angulated 5 to 10 degrees in anteroposterior view for L1 and L2 vertebrae. After insertion of the screw into the pedicle, the position of the screw was checked in C-ARM.Screws were placed in the additional segments in the same fashion.

Pre operative CT gives details about the intactness of pedicles. If both the pedicles of fractured vertebra are intact without fracture, then two screws are inserted in them.If one pedicle is fractured, one screw is placed in the normal pedicle.If both pedicles are damaged, then pedicle screws are placed two levels above and two levels below the fractured vertebra.This gives good stability to the spine.

PLACEMENT OF RODS:

When screws have been placed in all the segments to be instrumented, the titanium rod of slightly longer length than needed was chosen to accommodate distraction.The rod was bent to match the lordotic curve. The rod was first inserted on one side, and the fracture was reduced and fixed with inner screw using screw inserter. The rod was fixed in all other pedicle screws in the same manner.

REDUCTION:

The prone position of the patient itself reduced the fracture in most cases.If the fracture is not reduced,then a distractor was used to reduce the fracture.Final tightening of the inner screws was done with rod stabiliser that holds the screw and rod and inner screw tightner. The reduction was conformed with posteroanterior and lateral C-arm images

DECOMPRESSION:

Laminectomy was done if there was a posterior laminar defect at or near the fracture site, or if cerebrospinal fluid was visible. In patients with cord compression, decompression was performed using a nibbler and up cutter.The ligamentum flavum was removed and partial laminectomy done. Care was taken to avoid damage to the cord or nerve root by using a dural retractor.A nibbler was used to decorticate the remaining lamina and transverse processes.

In selected cases,through a separate incision, the posterior iliac crest was exposed to harvest morcellized bone for grafting. The bone graft was placed over the decorticated spinal elements. Thorough saline wash was given and the paraspinal muscles were closed in two layers.The fascia was closed tightly with vicryl. The subcutaneous tissue was closed over a closed suction drain.The skin was closed with a non absorbable suture material.Sterile dressing was applied.

Post operative management:

All the patients were given post op intravenous antibiotics for 7 days. They were switched over to oral antibiotics till suture removal. Physiotherapy was started from first day post operatively. On the second day patients were allowed to roll from side to side. They were allowed to sit up and were mobilized on a wheel chair after application of Taylor's brace on the third post operative day. A close watch was kept for any improvement or deterioration in the neurological status A neurological examination was done daily. Patients were allowed to stand and walk with support after the lower limb power improved under the guidance of the physiotherapist.Taylor's brace was worn on all times of the day except when the patient is lying down. The brace was used for two months post operatively.Sutures were removed on the 12^{th} post operative day.

Follow up:

All the patients were followed up at interval of 6thweek,12th week,6months and 1 year respectively.On each follow up clinical, radiological & neurological examination was done to assess spinal stability,reduction in pain,improvement in range of movements,reduction of deformity,and check for any complications.Bladder training was given to patients who were affected with urinary incontinence.

FOLLOW UP ASSESSMENT:

1.NEUROLOGICAL ASSESSMENT:

Neurological examination was done using the ASIA scale at regular visits.

2.RADIOLOGICAL ASSESSMENT:

Radiological assessment was done by measuring

a.Regional kyphotic angle

b.Anterior vertebral body height .

Regional kyphosis was measured from the inferior end plate of the intact vertebra above the fracture to the superior end plate of the intact vertebra below the fracture. Anterior vertebral body height was measured with standard lateral view of spine .

3.CLINICAL ASSESSMENT:

Clinical assessment was done using the Denis pain scale and Denis work scale.

DENIS PAIN SCALE:

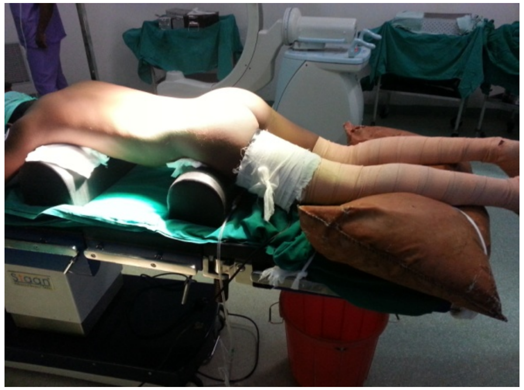
Grade	Criteria
1	No pain
2	Occasional, minimal pain : no need for medication
3	Moderate pain, occasional medication, no interruption of work or activities of daily livings
4	Moderate to severe pain, occasional absences from work, significant in activities of daily livings
5	Constant severe pain, chronic medication

DENIS WORK SCALE:

Grade	Criteria
1	Return to previous employment(heavy labor) or physically demanding activities
2	Able to return to previous employment(sedentary) or return to heavy labor with lifting restrictions
3	Unable to return to previous employment but working full time at a new job
4	Unable to return to full time work
5	No work, completely disabled

SURGICAL PROCEDURE

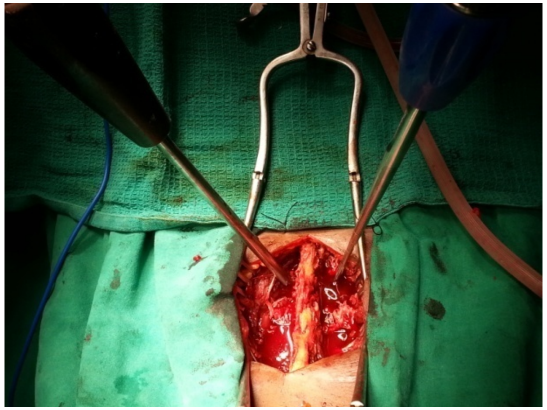
POSITION



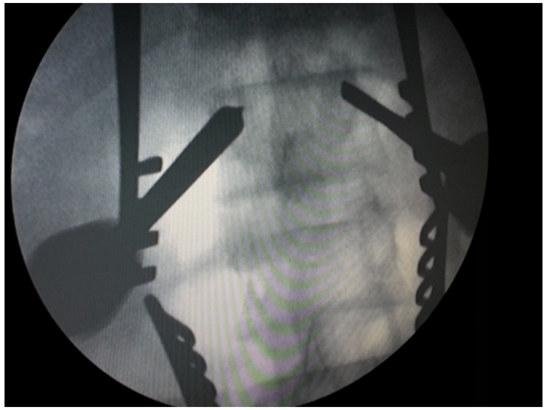
INJECTION OF ADRENALINE SOLUTION

PARASPINAL MUSCLES ERASED WITH COBB,S ELEVATOR

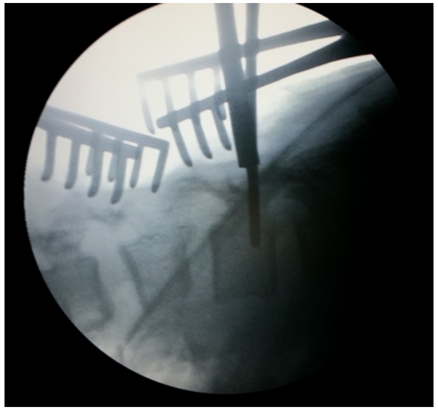
ENTRY POINT WITH PEDICLE AWL

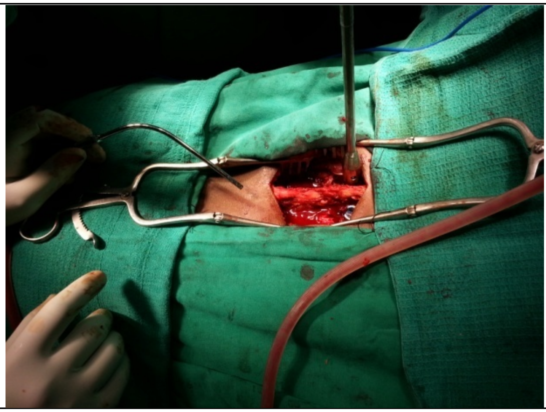
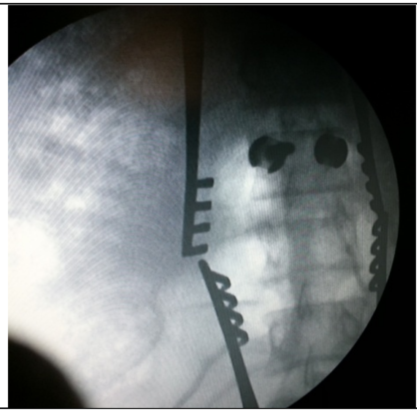
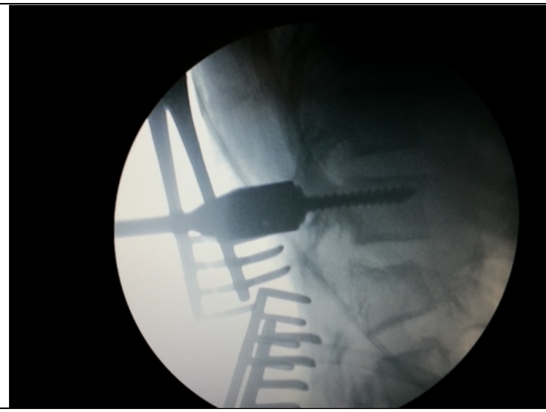
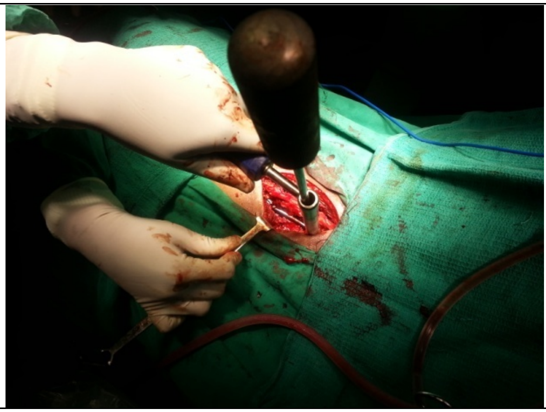
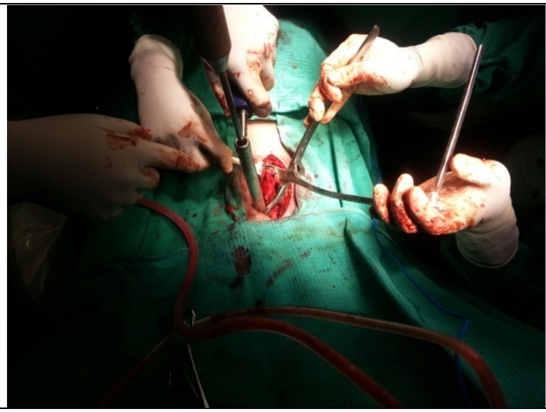
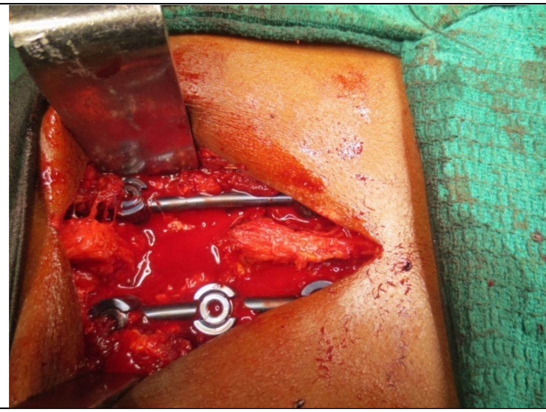


POSITION CHECKED IN AP VIEW



LATERAL VIEW-AWL AND PROBE IN POSITION



INSERTION OF PEDICLE SCREW	C-ARM AP VIEW	LATERAL VIEW
		
INNER SCREW TIGHTNING	DISTRACTION	DECOMPRESSION
		

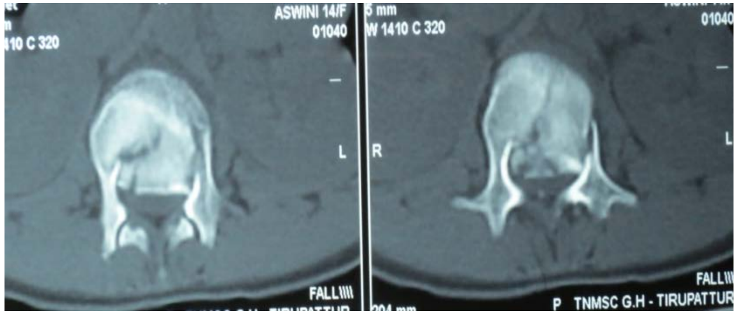
CASE - I NAME:ASWINI AGE/SEX:15/F IP.NO:5304 DIAGNOSIS:AO TYPE A # L1 VERTEBRA

PRE OP X-RAY

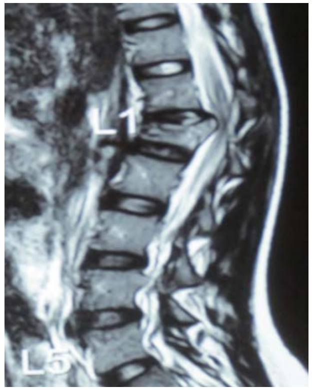
AP

LATERAL

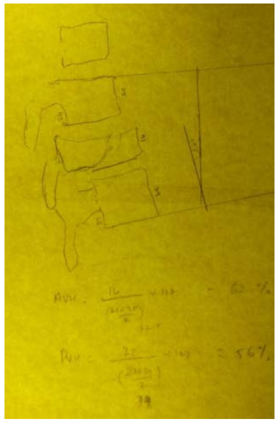
PRE OP - CT



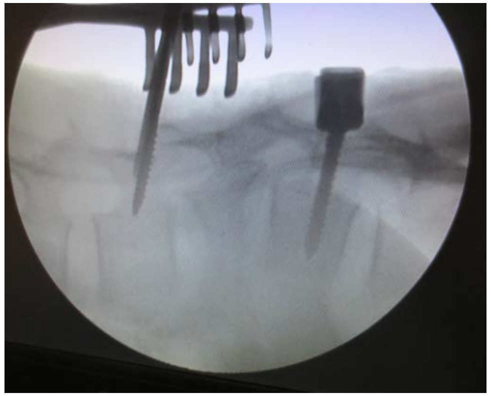
MRI

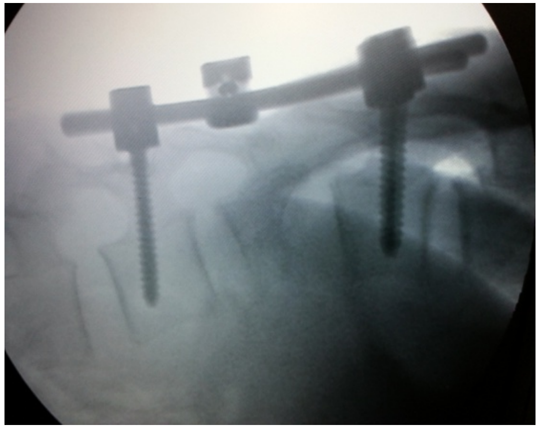


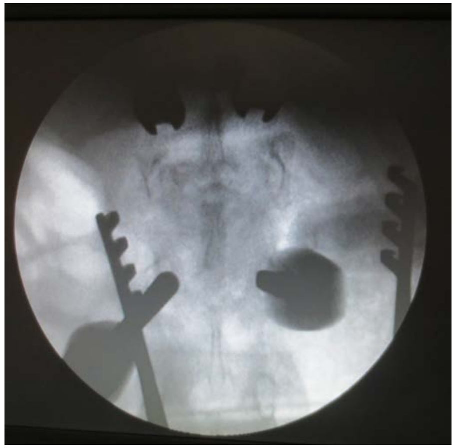
TEMPLATE

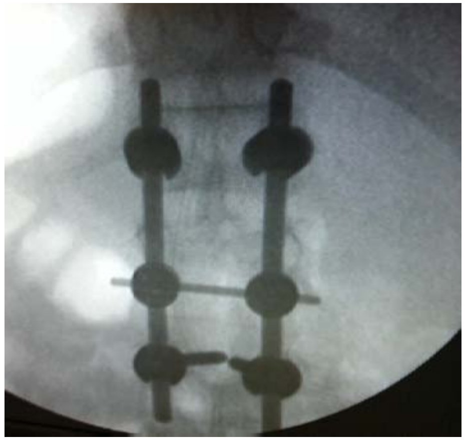


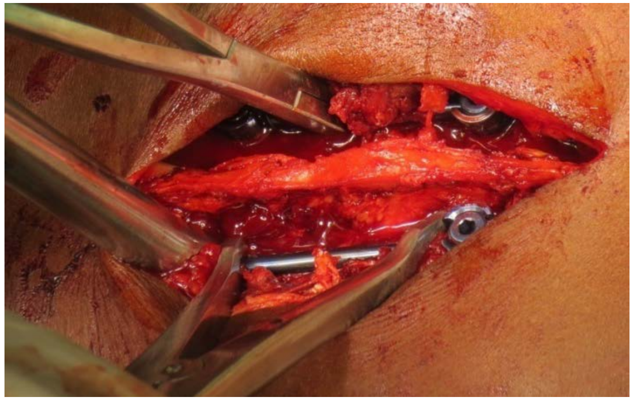
PER OP - PICTURES





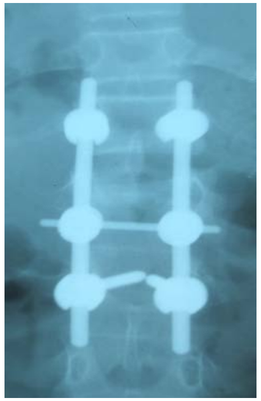




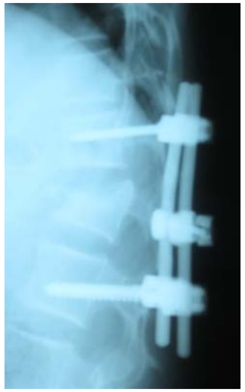


POST OP

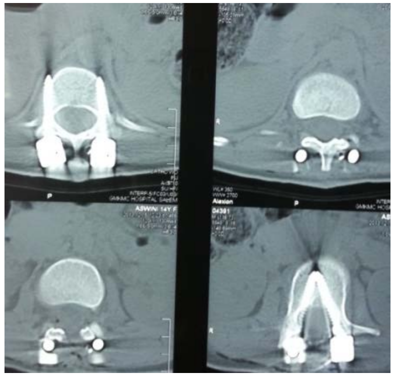
AP



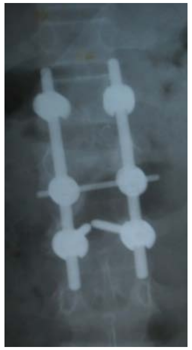
LATERAL



POST OP – CT



6 MONTH



1 YEAR

CLINICAL PICTURES

CASE-II NAME:AJITH KUMAR AGE/SEX:14/M IP.NO:7874 DIAGNOSIS:AO TYPE B # L2 VERTEBRA

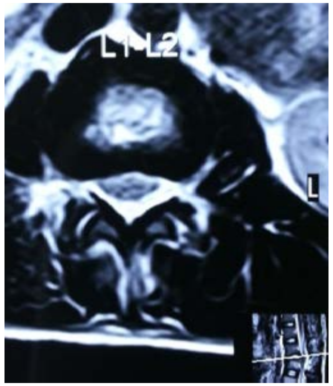
PRE OP X-RAY

AP

LATERAL

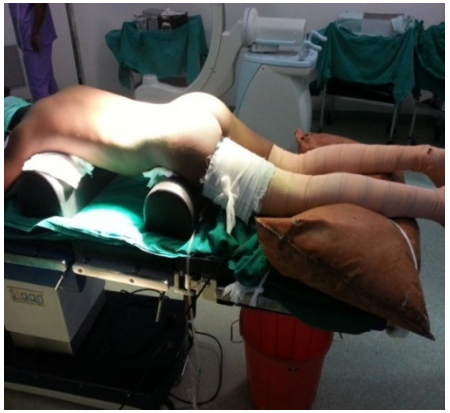
PRE OP – CT

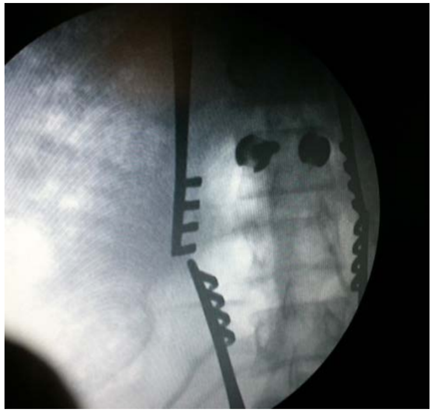
MRI

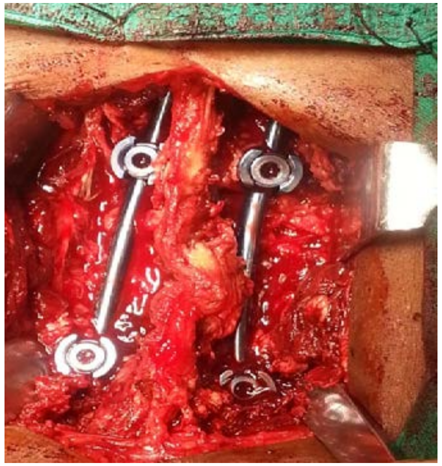


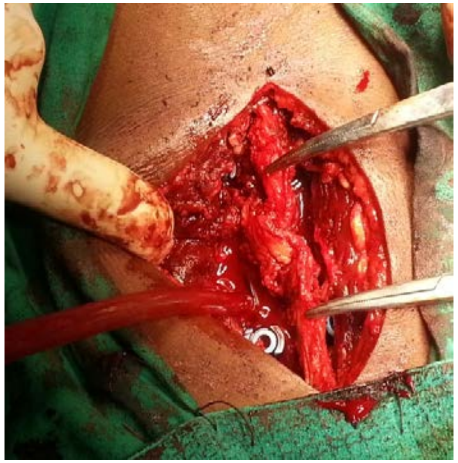
TEMPLATE

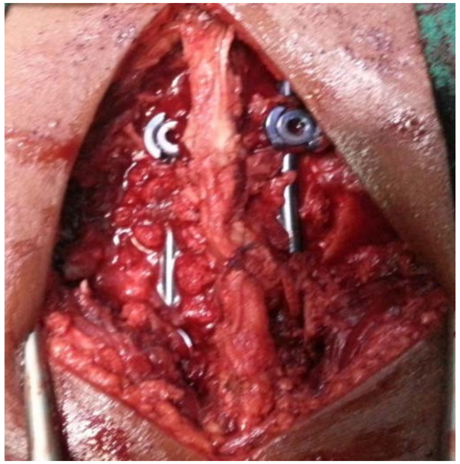
PER OP







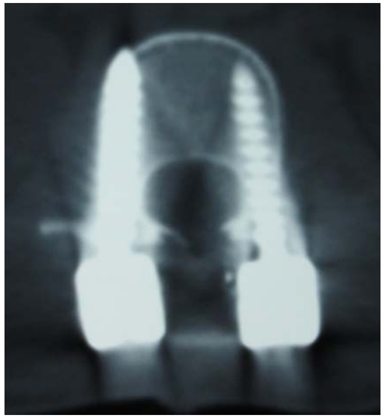


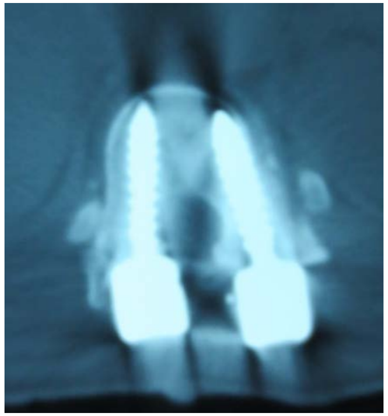


POST OP

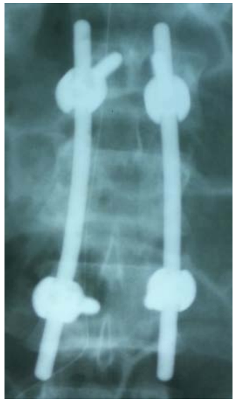
X-RAY

CT



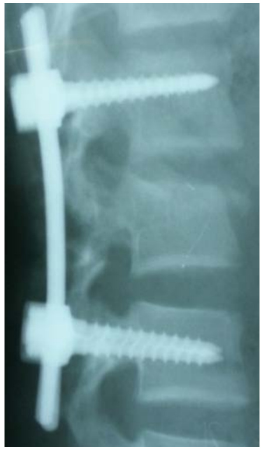


AP

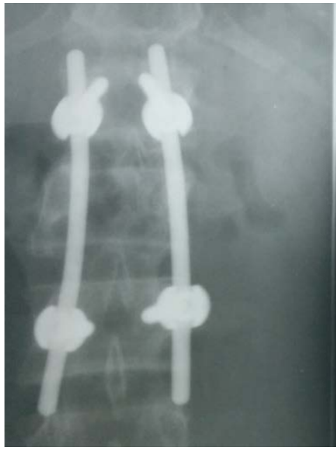


LATERAL

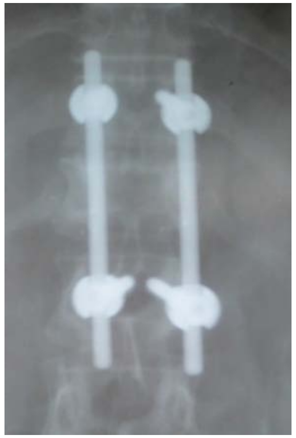
1 MONTH



6 MONTH



1 YEAR



CLINICAL PICTURES

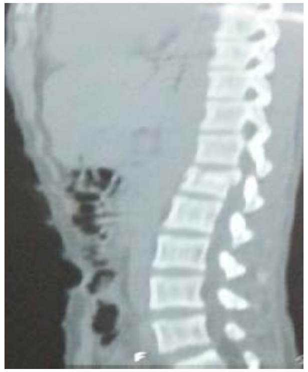
CASE-III NAME:ANANDAKUMAR AGE/SEX:34/M IP.NO:58242 DIAGNOSIS:AO TYPE A #L1 VERTEBRA

PRE OP X-RAY

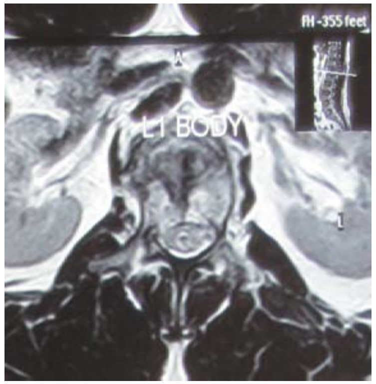
AP

LATERAL

PRE OP – CT

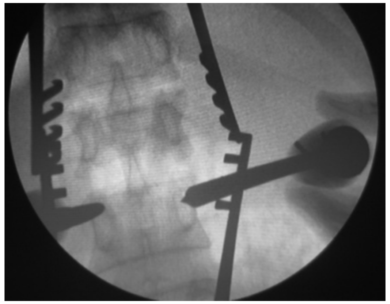


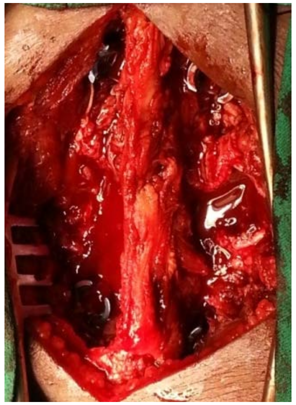
MRI



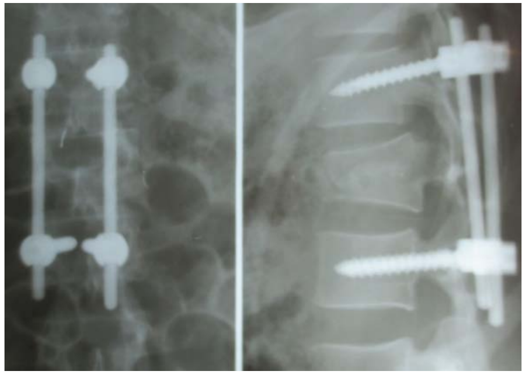
TEMPLATE

PER OP

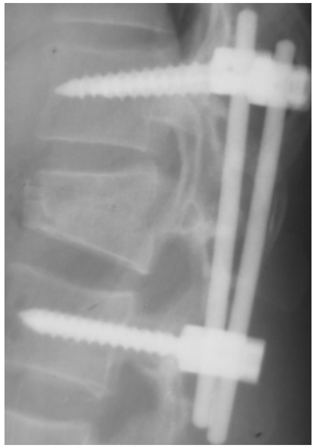


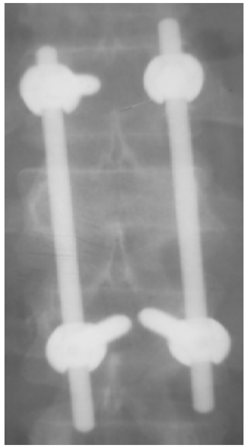


POST OP



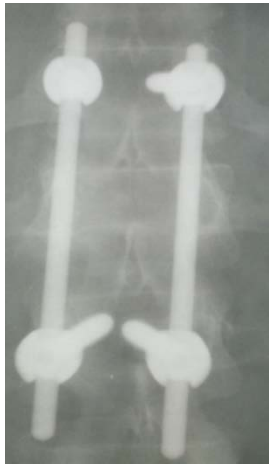
1 MONTH

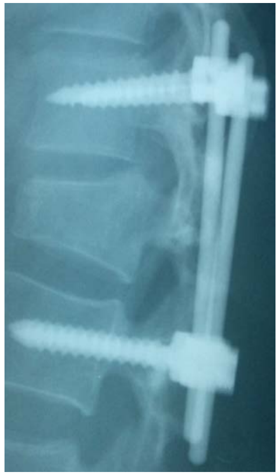




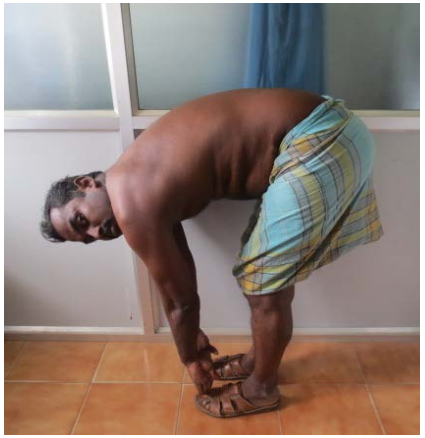
6 MONTH

1 YEAR





CLINICAL PICTURES



CASE IV:NAME:GANESAN AGE/SEX:55/M IP.NO:53020 DIAGNOSIS:AO TYPE A #L1 VERTEBRA

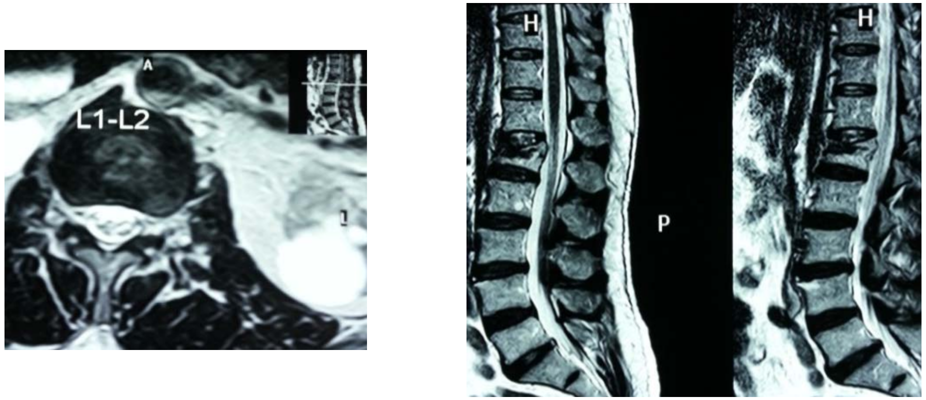
PRE OP: X-RAY

AP

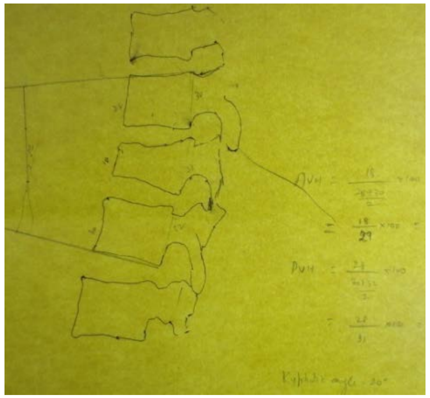
LATERAL

PRE OP - CT

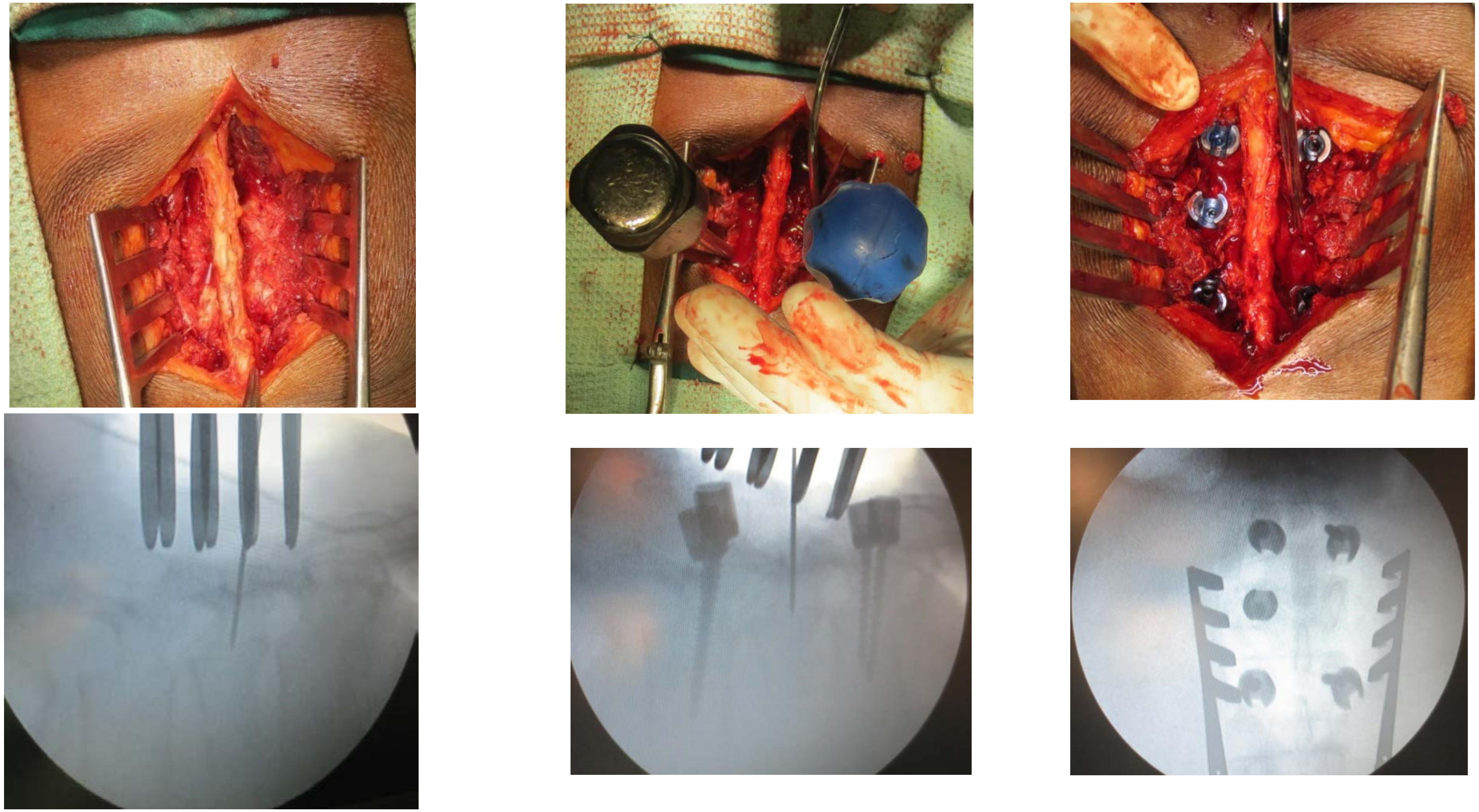
MRI



TEMPLATE



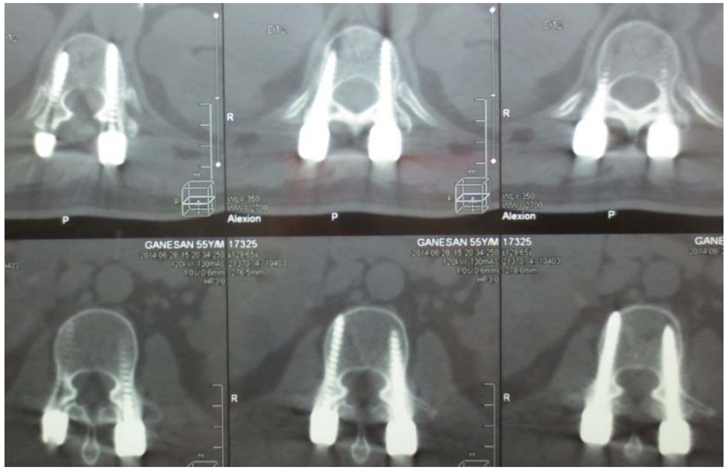
PER OP



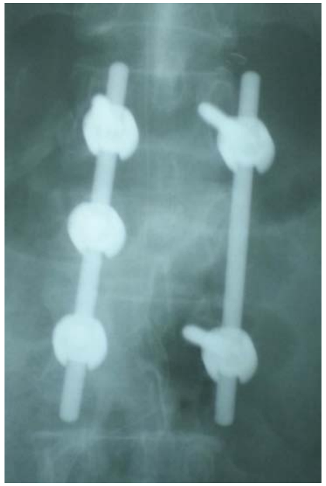
POST OP

X-RAY

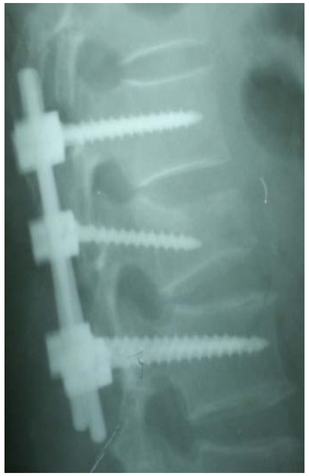
CT



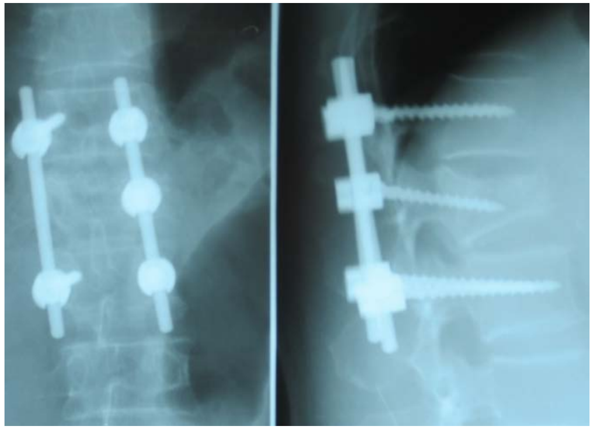
AP



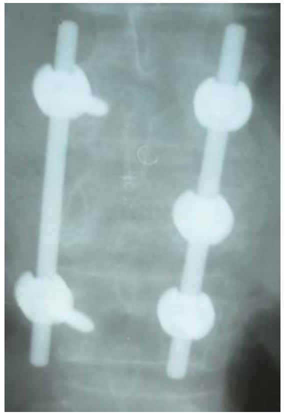
LATERAL

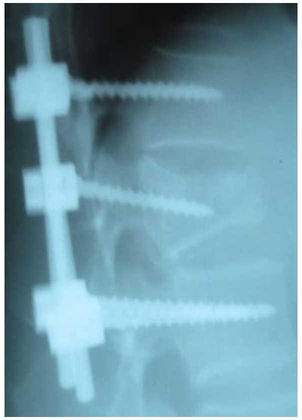


1 MONTH

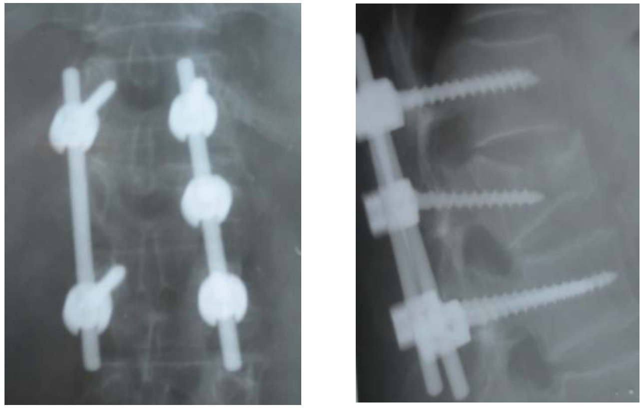


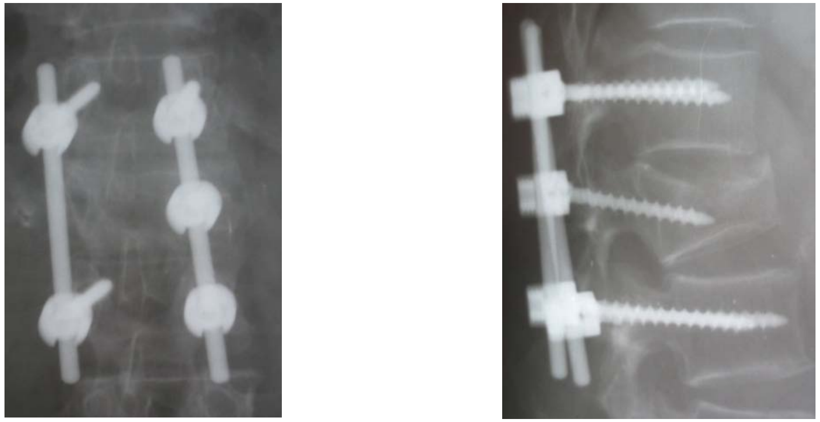
3MONTH





6 MONTH **1 YEAR**





CLINICAL PICTURES

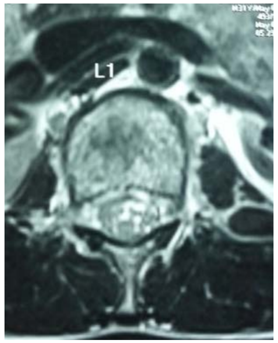
CASE – V NAME:DARMALINGAM,31/M IP.NO:40684 DIAGNOSIS:AO TYPE A #L1 VERTEBRA

PRE OP X-RAY

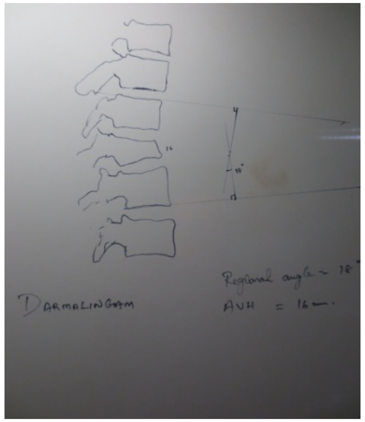
AP

PRE OP - CT

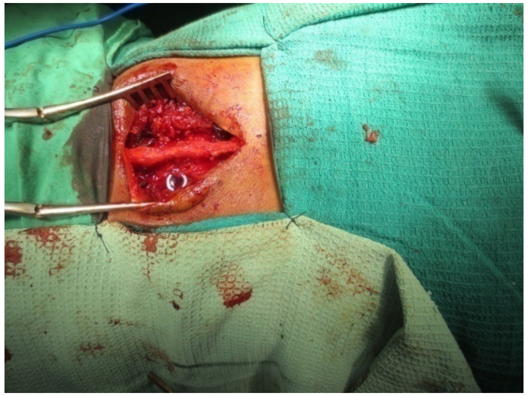
MRI

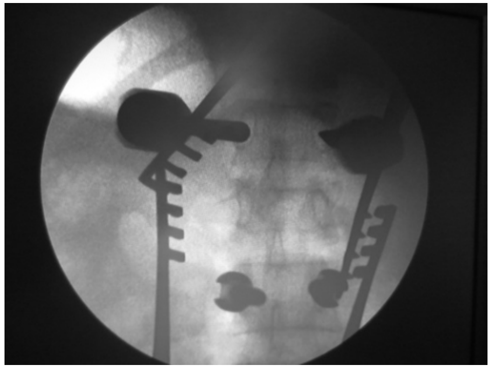


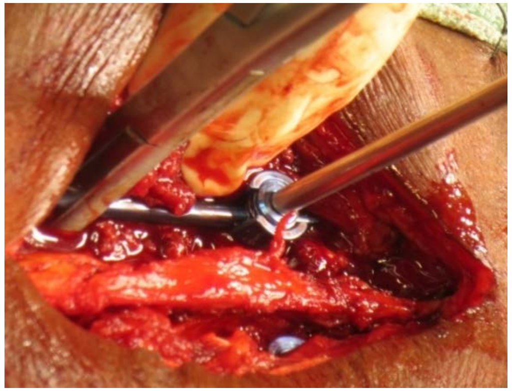
TEMPLATE

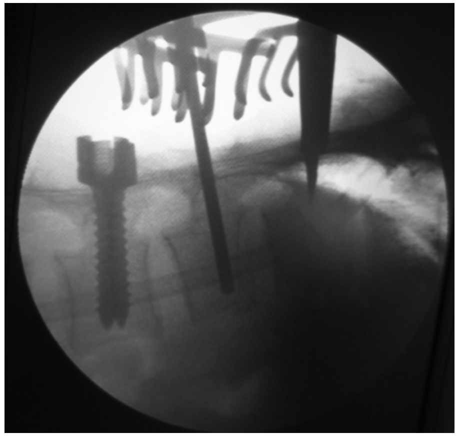


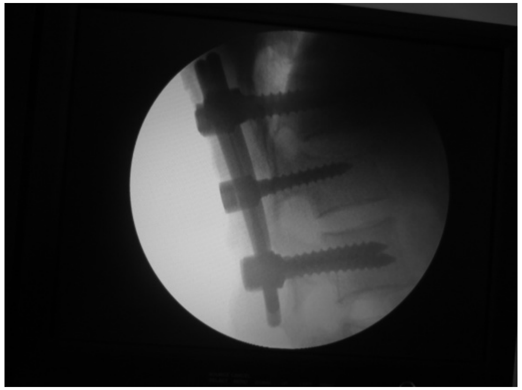
PER OP

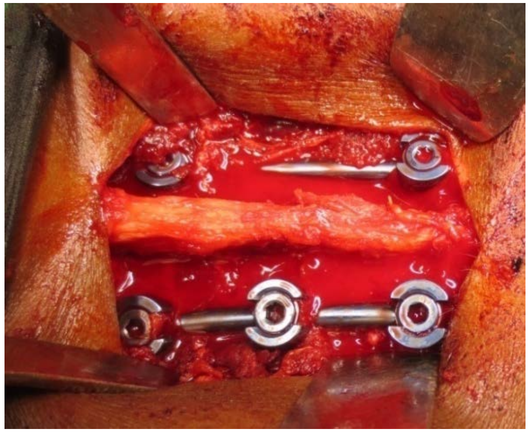






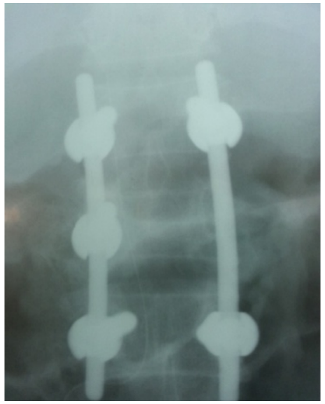






POST OP X-RAY

AP

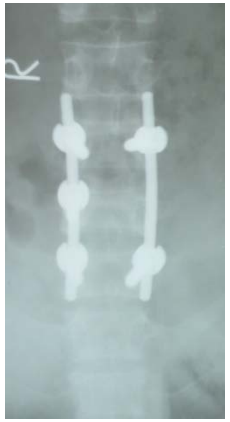


LATERAL

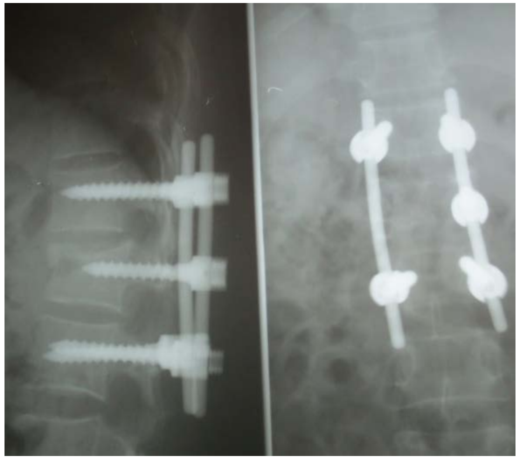
POST OP CT

FOLLOW UP

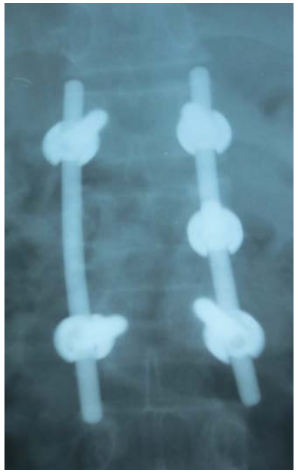
1 MONTH

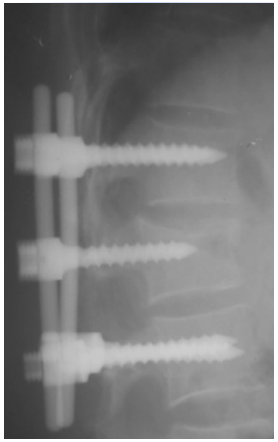


6 MONTH



1 YEAR





CLINICAL PICTURES



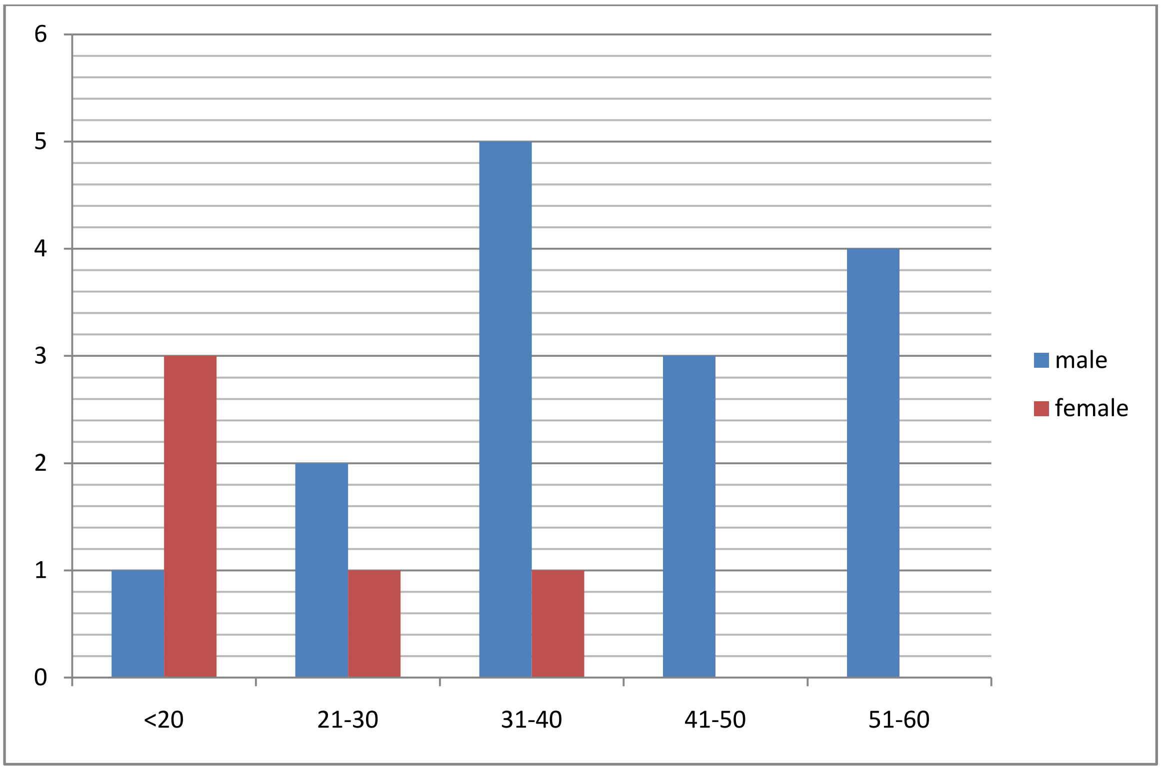

RESULTS.

AGE AND SEX DISTRIBUTION

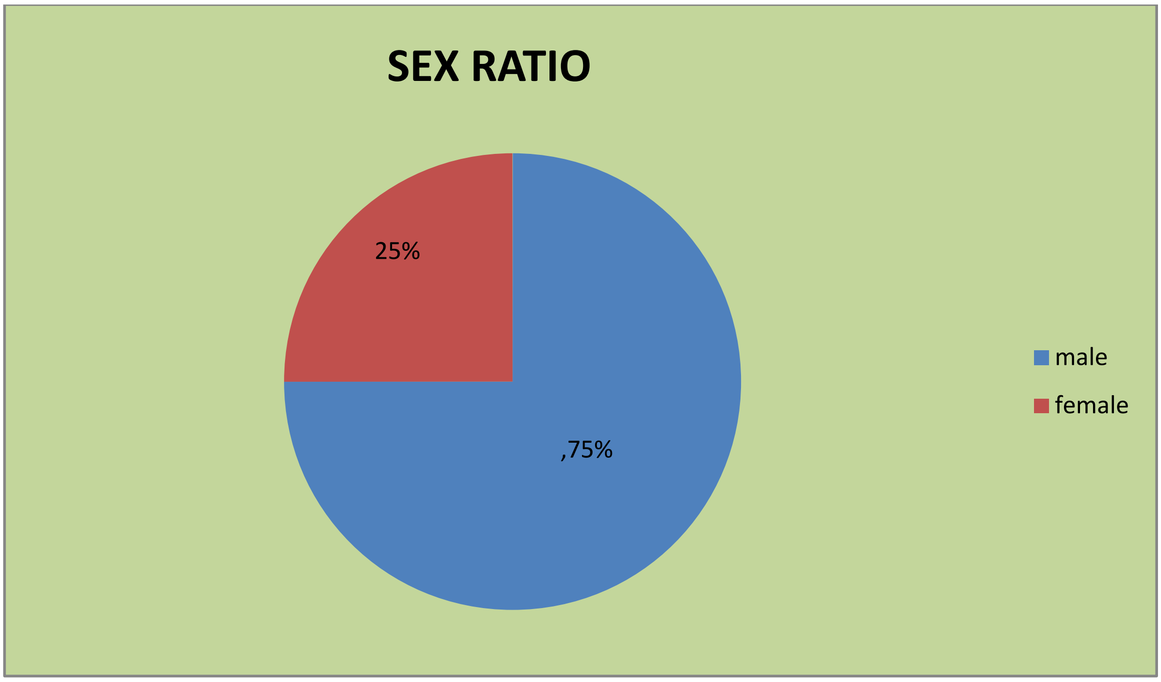
In this series 15(75%)patients were male and 5 (25%) were female patients .6 (30%) patient was below 20 years, 9 (45%) were in the 21-30 age group and 5 (25%) were in the 30 and above age group.

AGE	MALES	FEMALES
<20	1	3
21-30	2	1
31-40	5	1
41-50	3	0
51-60	4	0

AGE AND SEX DISTRIBUTION



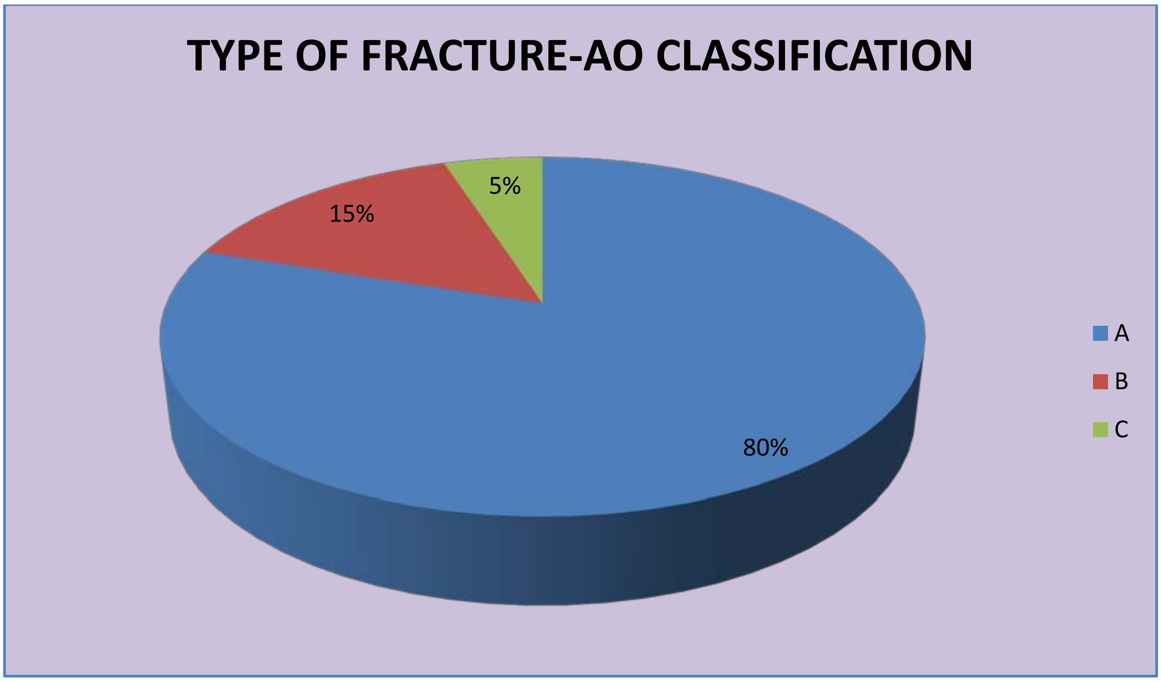
AGE GROUP



TYPE OF FRACTURE

In this series there were 16(80%) of type A fractures, 03(15%) of type B fractures, and 01(5%) of type C fractures.

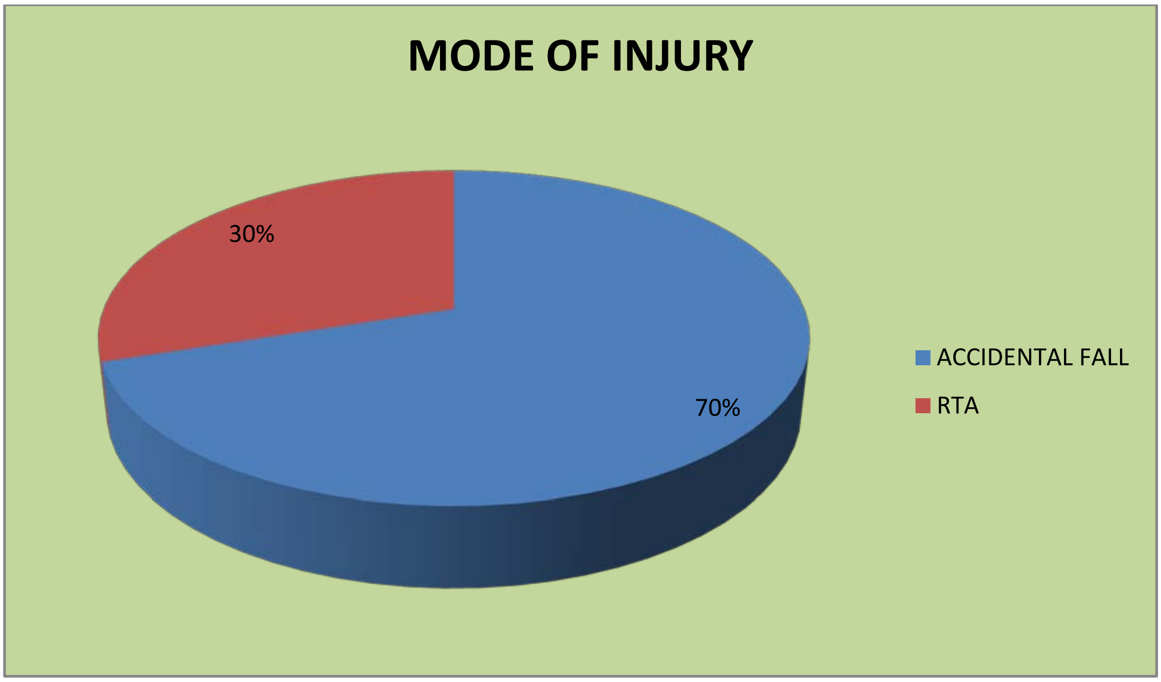
AO CLASSIFICATION	NO; OF PATIENTS	PERCENTAGE
A	16	80
B	03	15
C	01	5



MODE OF INJURY

In this series we had 14(70%) patients had accidental fall as most common mode of injury and 06(30%) were having road traffic accident as mode of injury

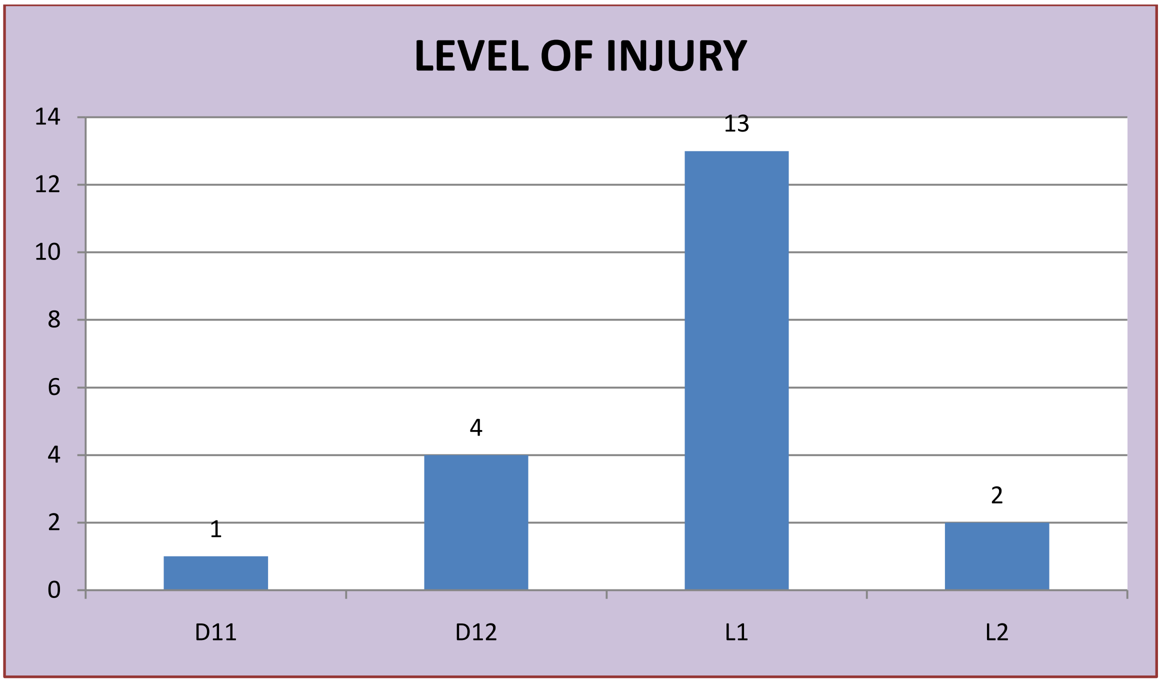
MODE OF INJURY	NO: OF CASES	PERCENTAGE
RTA	06	30
ACCIDENTAL FALL	14	70



LEVEL OF INJURY

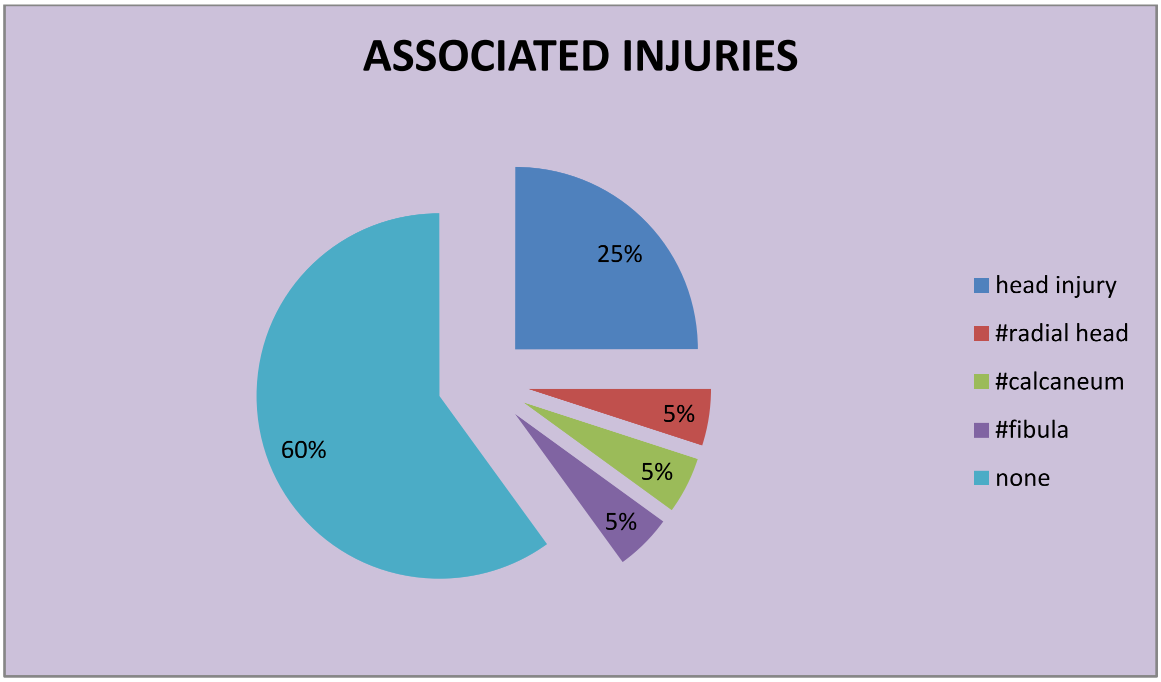
In this series we had o1(5%) patient had fracture at D11 level , 4(20%) patients had fracture at D12 level,13(65%) patients had fracture at L1 level and 02(10%) patients had fracture at L2 level

LEVEL	NO: OF PATIENTS	PERCENTAGE
D11	01	5
D12	04	20
L1	13	65
L2	02	10



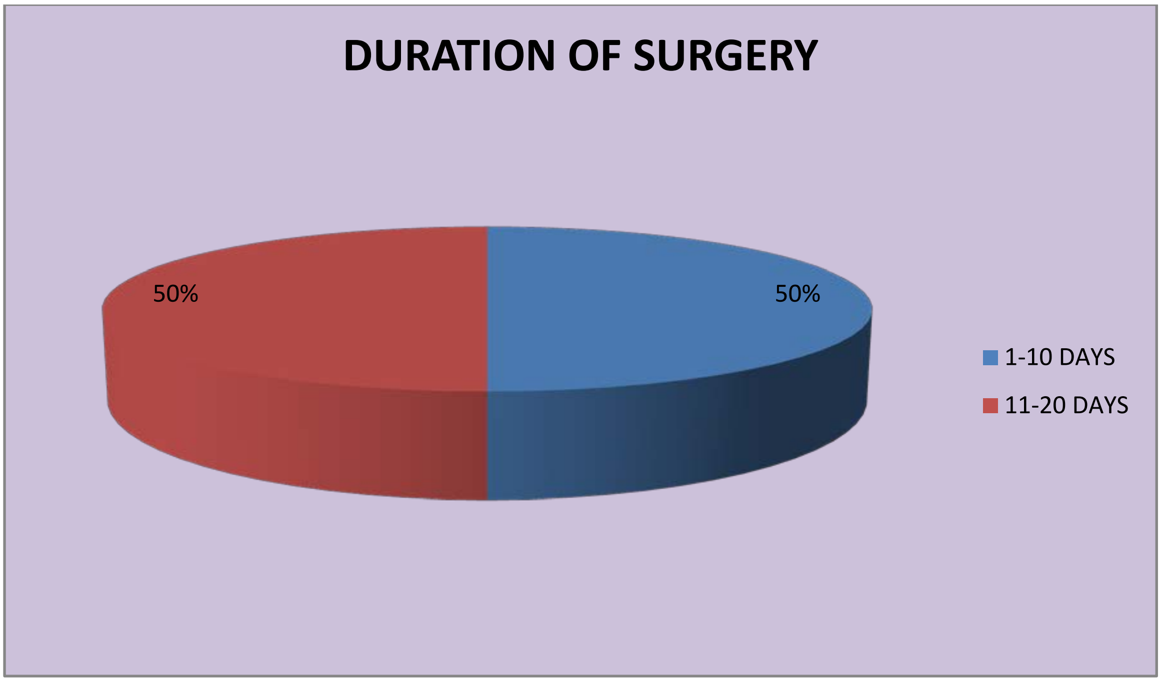
ASSOCIATED INJURIES:

In our study, 5(25%) patients had associated head injury,1(5%) patient had fracture radial head with elbow dislocation,1(5%) patient had calcaneus fracture and 1(5%) patient had fracture of fibula.12(60%) patients had no other injury.



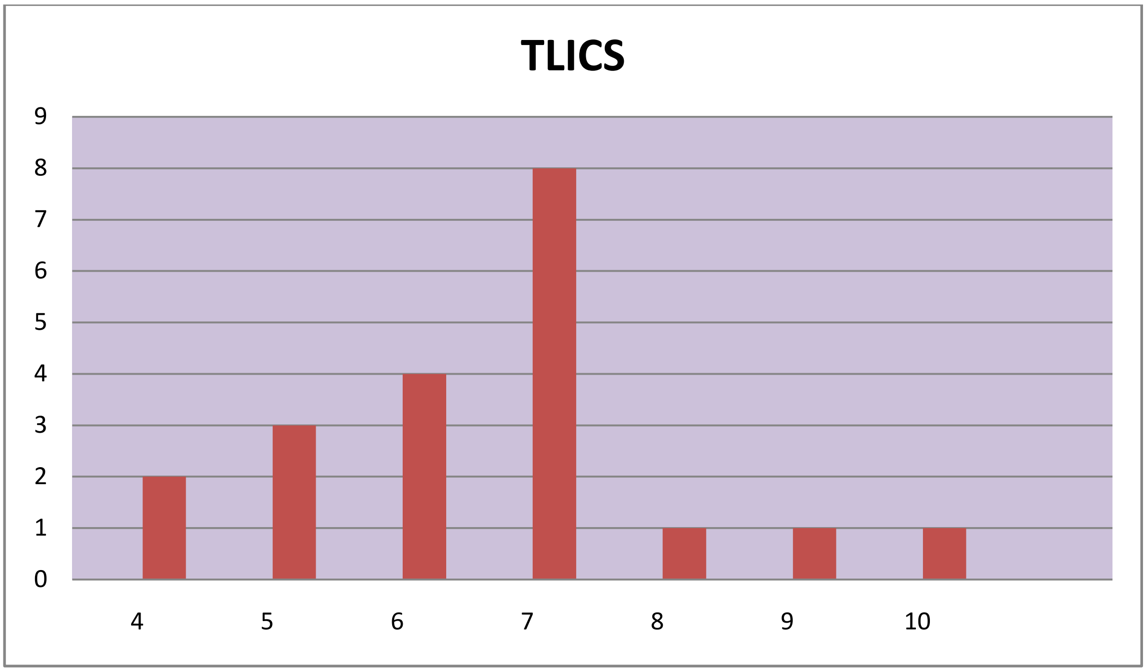
DURATION OF INJURY TO SURGERY:

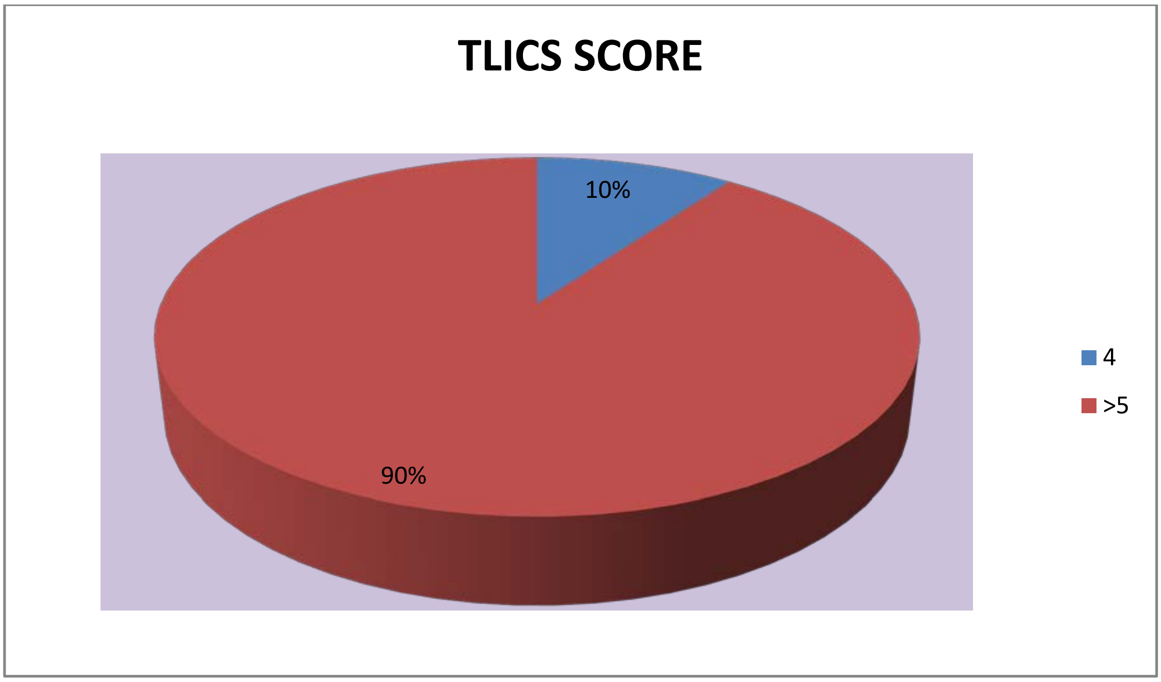
In our study, 10(50%) patients underwent surgery within 10 days of admission and 10(50%) patients had surgery within 20 days of surgery.



TLICS SCORE

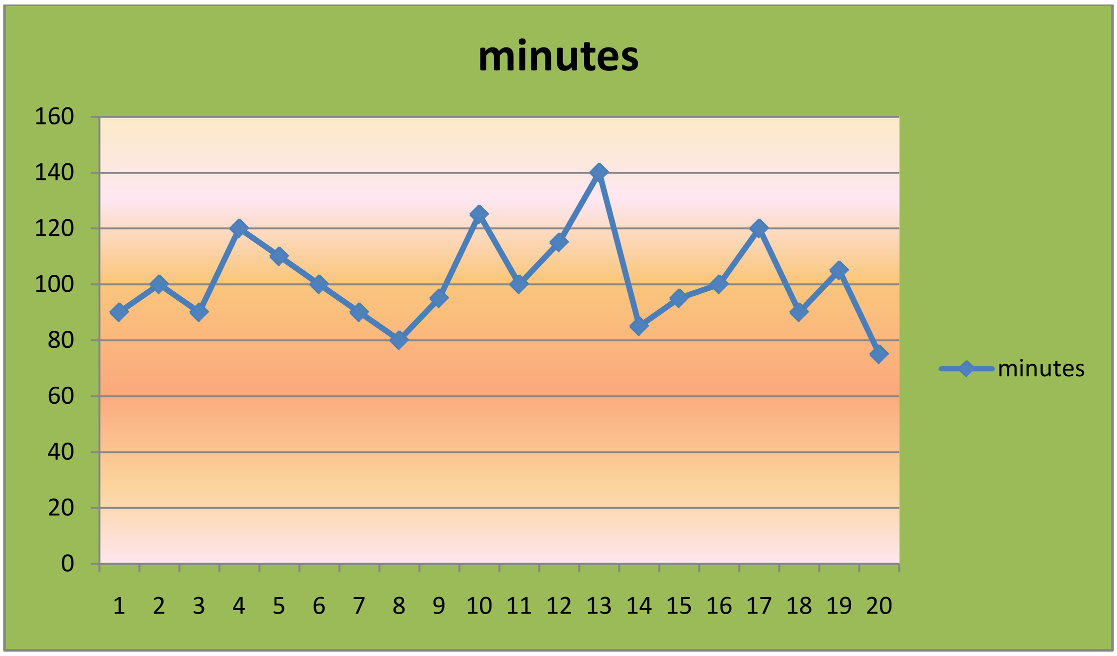
In this series,2 patients (10%) had TLICS score of 4, and 18(90%) patients had a score of 5 and above





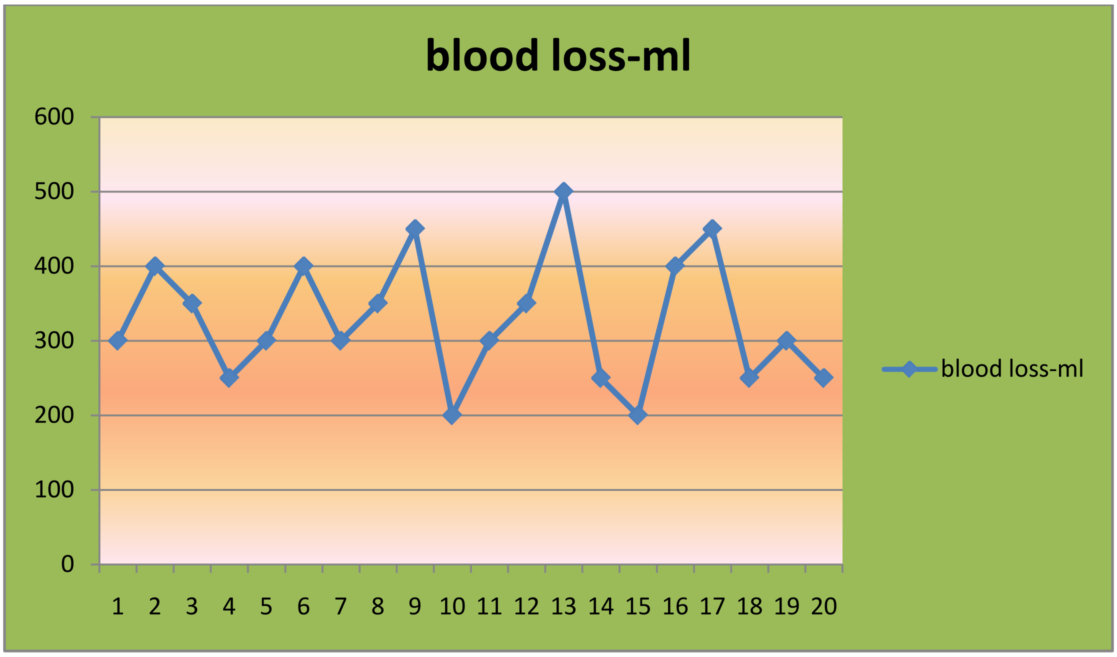
DURATION OF SURGERY

The average duration of the surgical procedure was 1 hour and 41 minutes.



BLOOD LOSS

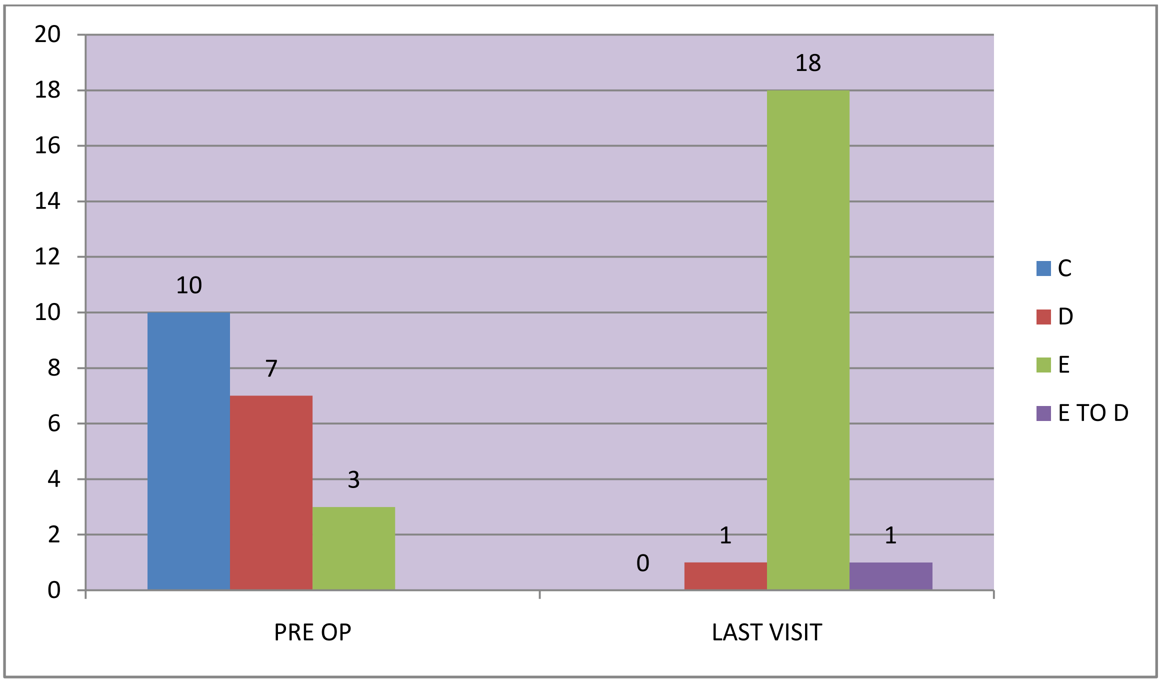
The average blood loss during surgery was 328 ml.



NEUROLOGICAL ASSESSMENT

ASIA GRADING SYSTEM

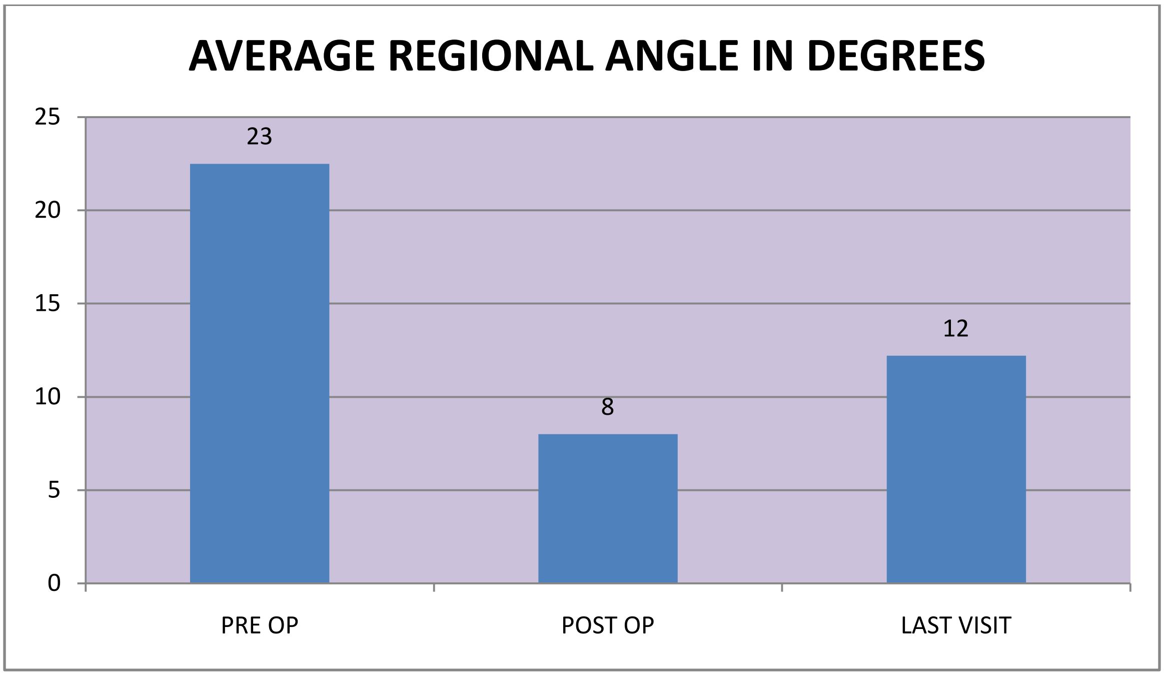
In our series, 10(50%) patients presented with ASIA scale C, 7(35%) patients with D , and 3(15%) patients with ASIA scale E. At the end of 1 year, 1 patient(5%) had ASIA scale D , and 18 patients(90%) had a scale of E. 1(5%) patient had a decrease in the neurological status from scale E to D.



RADIOLOGICAL ASSESSMENT

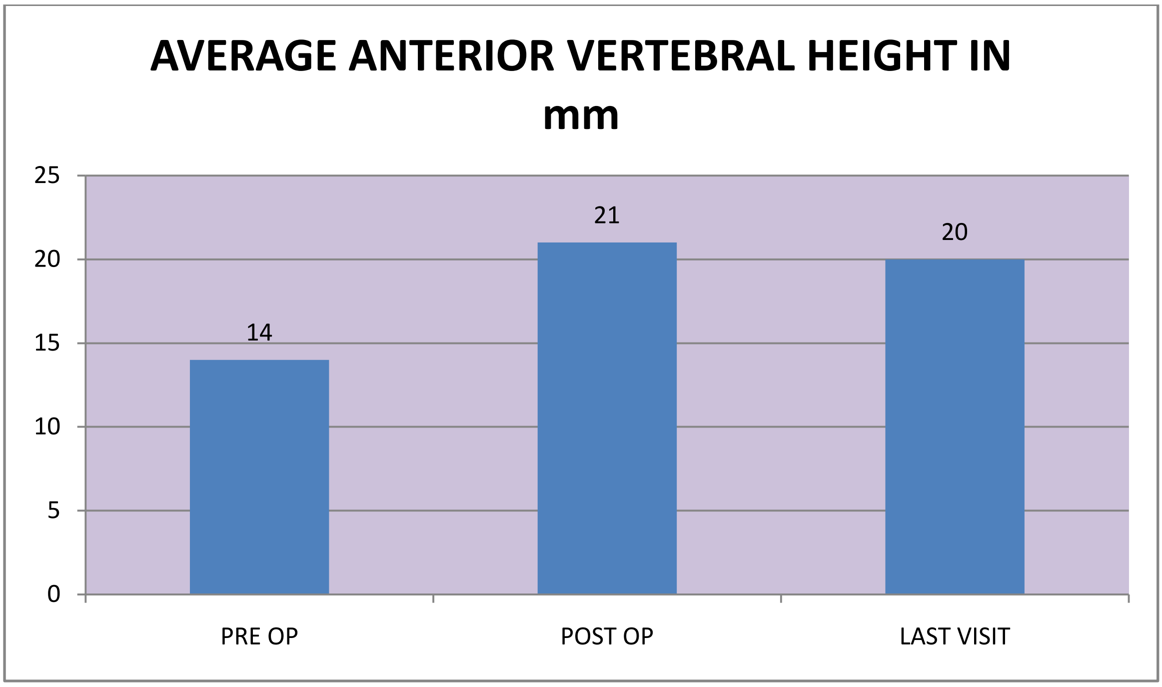
REGIONAL ANGLE

In our series, average regional angle of 20 patients is 22.5 degree, where as post operative angle was 8 degree and average angle at the last visit was 12.2 degree.



ANTERIOR VERTEBRAL HEIGHT

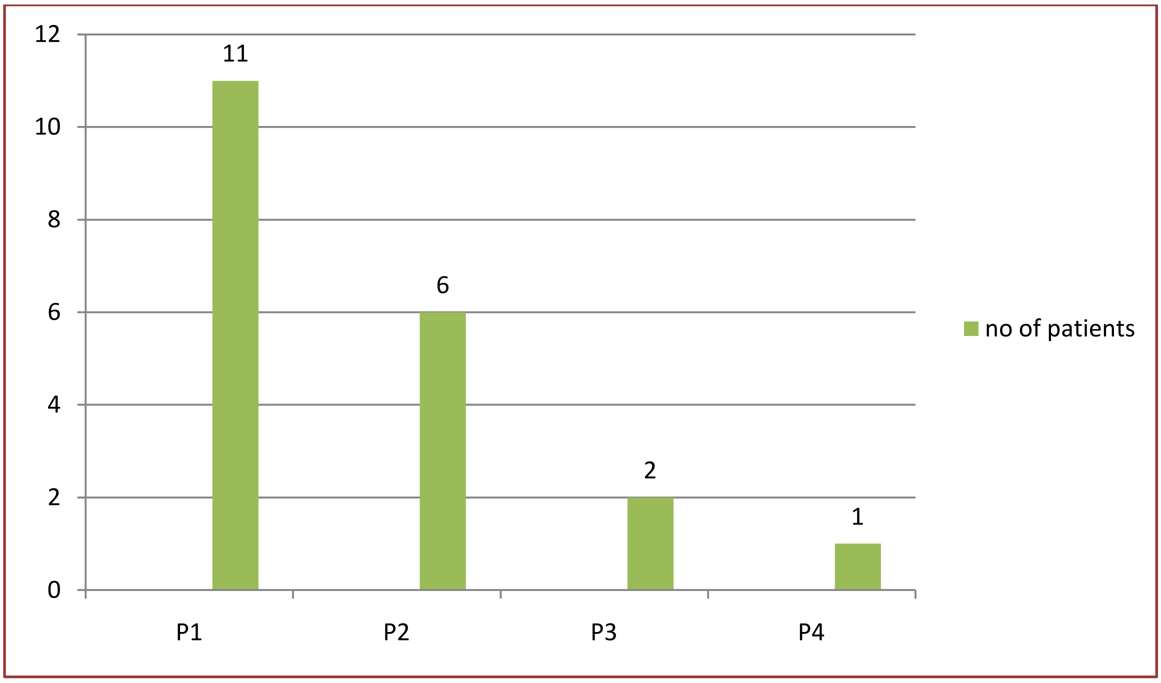
In our series, average anterior vertebral height among 20 patients is 13.5mm where as height in post operative height was 21.3mm and in last visit was 20.4 mm.



CLINICAL ASSESSMENT

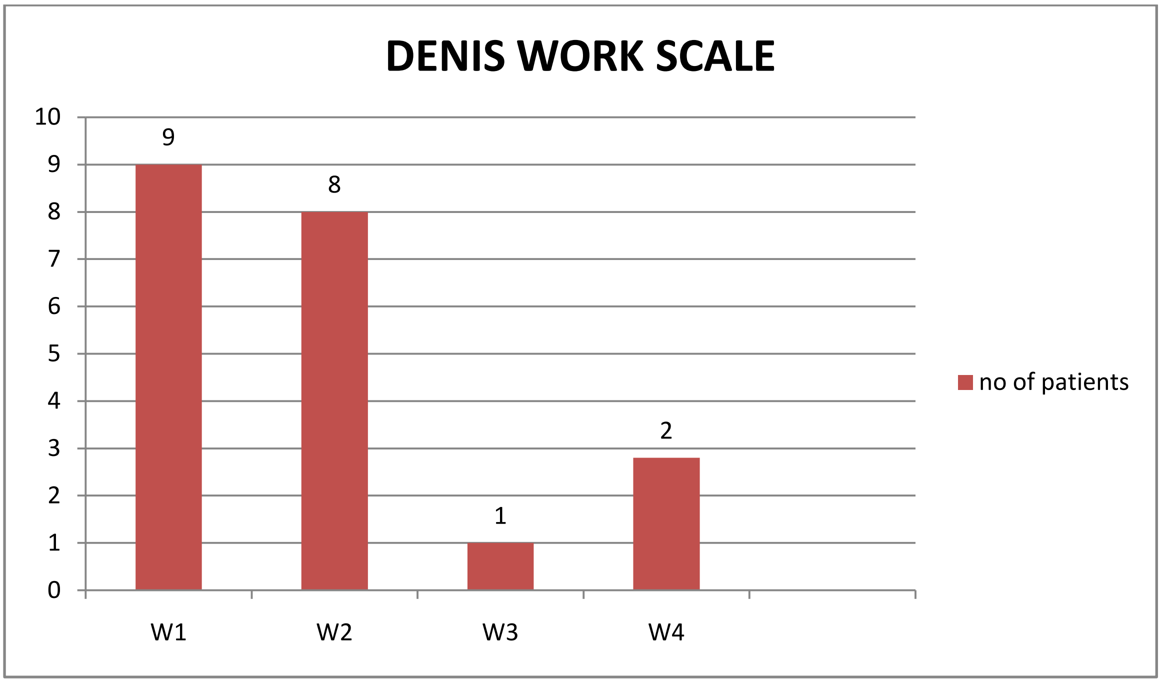
DENIS PAIN SCALE

In our series,out of 20 pateints,11(55%) were having denis pain scale of P1,06(30%) were having scale of P2 ,2(10%) patients were having scale of P3and 1(5%) patient was having a scale of P4



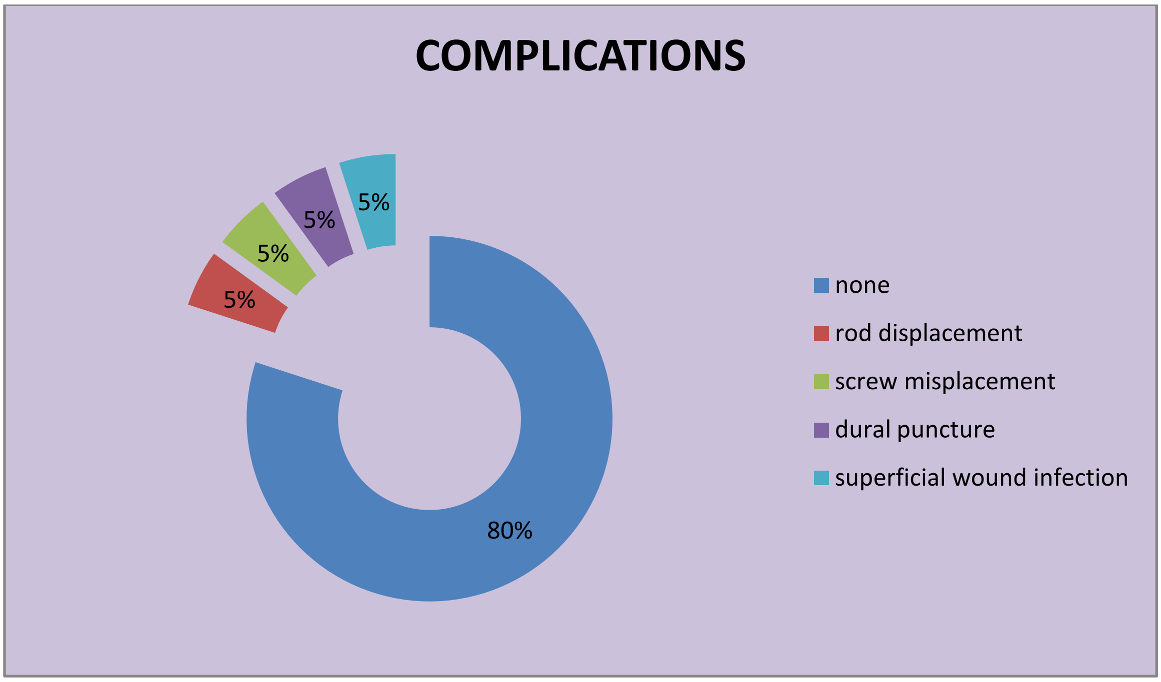
DENIS WORK SCALE

In our series,out of 20 patients , 09(45%) were having denis work scale W1,08(40%) were having work scale of W2,01(5%) patient was having W3 & 2(10%) patients were having work scale W4



COMPLICATIONS:

In our study, 16(80%) patients had no complications. 1(5%) patient had rod displacement,1(5%) patient had screw misplacement and 1(5%) patient had dural puncture and 1(5%) patient had superficial wound infection.



DISCUSSION

AGE AND SEX DISTRIBUTION:

In our study we had 75% males and 25% female patients. The average age was 36.6 years and more common in the third and fourth decade. Gregory F. Alvine et al in their study found that average age was 31 years, with a male predominance. Rick C. Sasso et al, in their study had 77% males and 23% females with a mean age of 34 years. Razak M, et al in their study found that average was 30 with a male predominance.

Authors	Mean age(years)	Sex
Gregory F. Alvine et al	31	Male
Rick C. Sasso et al	34	Male
Razak M, et al	30	Male
Present study	36.6	Male

MODE OF INJURY:

In our study we noted fall from a height in 70% patients as the most common mode of injury and was mainly the result of work injury. Road traffic accident was the second commonest cause 30% of patients .

Nasser M.G, et al in his study noted that the main cause of injury was fall from a height and road traffic accident was the second commonest. Gregory F. Alvine, et al noted that in 52% of patients injuries resulted form fall from a height, in 39% patients due to road traffic accidents and 9% due to fall of heavy objective. Razak M, et al in his study noted that 69% of injuries were caused from fall from height, 31% due to road traffic accident.

Authors	Accidental fall	RTA
Nasser M.G, et al	67%	24%
Gregory F. Alvine, et al	52%	39%
Razak M, et al	69%	31%
Present study	70%	30%

CLASSIFICATION TYPE:

In our series we found 80% of patients with AO Type-A fractures, 15% with AO Type-B fractures and 5% with AO Type-C fractures. Nasser M.G. et al., in their study noted 76% of patients with Type-A, 8% with Type-B and 16% with Type-C. Rick C.Sasso et al., noted that 62.5% had AO Type-B and 37.5% had AO Type-A fractures. Gregory

F.Alvine et al noted that Type-B fractures were seen in 57.5% of patients Type-A in 22.5% and 20% with Type-C.

Authors	A	B	C
Gregory E. Alvine et al	57%	13%	30%
Nasser M.G, et al	76%	8%	16%
Rick C. Sasso et al	62.5%	37.5%	-
Present study	80%	15%	5%

LEVEL OF INJURY

The most common vertebrae involved in this series were between T11 – L2 to the extent up to 100%. While Alvine noted to the extent of 70%, Sasso et al noted up to 80% and Razak et al noted to the extent of 92% of the fractures were at the level of T11 – L2

Authors	Level of injury (T11-L2)
Alvine et al	70%
Sasso et al	80%
Razak et al	92%
Present study	100%

ASSOCIATED INJURIES:

In our study, 5(25%) patients had associated head injury,1(5%) patient had fracture radial head with elbow dislocation,1(5%) patient had calcaneum fracture and 1(5%) patient had fracture of fibula.12(60%) patients had no other injury. CT brain was taken for patients with head injury and neurosurgeon fitness for surgery was obtained. 1 patient with elbow dislocation and fracture radial head was managed with closed manual reduction immediately and excision of radial head later.Patients with fracture calcaneum and fibula were managed conservatively.

DURATION OF INJURY TO SURGERY:

In our study, 10(50%) patients underwent surgery within 10 days of injury and 10(50%) patients had surgery within 20 days of surgery. Sasso et al noted that the average time interval between injuries to surgery was 4 days and mean hospital stay was 16 days. While Razak et al noted the average time duration to surgery was 5.6 days.

DURATION OF SURGERY

The average duration of the surgical procedure was 1 hour and 41 minutes.This avoided other complications due to general anaesthesia.

BLOOD LOSS

The average blood loss during surgery was 328 ml.This loss was compensated with one unit of blood transfusion intra operatively.

TLICS SCORE

In our study 18 (90%) patients had a score of 5 and above,which is an indication for surgery. 2(10%) patients had a score of 4.One patient had a regional angle of 30 degrees and a loss of anterior vertebral height of 60%.Other patient had a regional kyphotic angle of 32degrees and loss of anterior vertebral height of 69%.So these two patients were considered for surgery.

NEUROLOGICAL STATUS:

In our series, 10(50%) patients presented with ASIA scale C, 7(35%) patients with D , and 3(15%) patients with ASIA scale E. At the end of 1 year, 1 patient(5%) had ASIA scale D , and 18 patients(90%) had a scale of E. 1(5%) patient had a decrease in the neurological status from scale E to D.This was due to implant failure.Titanium rod got displaced and resulted in increase in kyphotic angle ,cord compression.All other patients had atleast 1 grade improvement in neurological status(95%).

Nasser M.G. et al., noted that patients who had neurological deficits showed at least 1 grade improvement at latest follow up. Gregory F Alvine et al., noted that neurological improvement was seen in 50% of cases with 40% improving with 1 grade and 20% with 2 grades and none had decrease in neurological level. Rick C.Sasso et al., in their study noted that all patients with incomplete neurological deterioration improved at least by 1 grade. Razak M et al, noted that 64.4% of those with incomplete lesions showed an improvement of at least 1 grade. Khan I et al., noted that 2 grade improvement in 18 patients (1.1 Grade improvement).

Authors	Neurological Improvement
Nasser MG et al	Atleast 1 Grade
Gregory F.Alvine et al.	1.2 Grade
Rick C. Sasso et al	Atleast 1 Grade
Razak M, et al	Atleast 1 Grade
Khan I et al.	1.1 Grade
Present Study	Atleast 1 Grade in 19 patients

RADIOLOGICAL PARAMETERS:

In our series the mean Regional angle by Cobb's method was 22.5° on admission, 8° post operatively and 12.2° at latest followup.

Nasser M.G et al., noted the kyphotic angle was 23.6° on admission, 7° post – operatively and 11.5° at latest followup. Rick C.Sasso et al., noted that the kyphotic angle was 17.6° pre operatively, 3.5° post operatively and 11.6° at latest follow up. Razak M. et al., noted that the average kyphotic angle was 20° pre operatively, 7° post operatively and 9° at latest follow up.

Authors	On Admission	Post Operative	Follow up
Nasser M.G. et al	23.6º	7º	11.5º
Rick C. Sasso et al	17.6º	3..5º	11.6º
Razak M, et al	20º	7º	9º
Present study	22.5º	8º	12.2º

ANTERIOR VERTEBRAL BODY HEIGHT:

A Study of **Rex AWM** involving vertebral body height improved from a mean of 42% preoperatively to 64% at the time of the latest follow-up. In a study by **Yaser MB** involving 70 patients with thoracolumbar fractures treated with pedicle screw instrumentation with mean follow up of 10 months, there was a significant improvement in anterior vertebral body height. Our study also shows improvement of vertebral height from a preoperative value of 13.5 mm to a value of 20.4 mm during the last follow up, i.e.,an improvement from 45% to 68% of vertebral height.

CLINICAL PARAMETERS:

In our study, 55% of patients had no pain(P1) at follow up and 30% patients had occasional mild pain(P2). Around 45% patients returned to their previous employment with heavy labour (W1) and 40% of patients returned to their previous heavy labour with lifting restrictions.(W2)

These results are comparable to a study conducted by Tae-Sob Shin et al of the Korean neurosurgical society in 2007 ,and the results were P1-57.9%,P2-36.8% and W1-52.6%,W2-20.5%.

COMPLICATIONS

SCREW ROD TNTERFACE FAILURE AND MISPLACEMENT:

Curtis AD in their metaanalysis of surgical treatment alternatives for fixation of unstable fractures of thoracic and lumbar spine, they analysed 15 articles including 614 patients and noted loss of fixation by disconnection of rod in 21patients (3.4%). Screw rod interface loosening and disconnection of rod with failure of construct was seen in 1 patient (3.1%).

Razak M et al, noted 2 instances of hardware loosening and 3 misplaced pedicle screw in their study.

Our study of 20 patients had 1 (5%) patient with rod didplacement form the pedicle screw, which is comparable to the above study. The patient developed kyphotic deformity and paraparesis.Since she was on 5 months amenorrhoea she was kept on regular follow up. She is planned for resurgery after delivery.

Compliations	Curtis AD et al	Razak. M et al	Present
Hardware Loosening	3.4%	8%	5%
Misplacement of Screws	-	12%	5%

The cause of rod pullout may be due to improper inner screw placement .In highly unstable fractures or in fractures where both pedicles are disrupted, stabilization should be done two segments above and two segments below the fractured vertebra.If one pedicle is intact, then one pedicle screw can be inserted in the intact pedicle.

1(5%) patient had pedicle screw misplacement.On follow up, he did not have any neurological symptoms or pain.So, the screw was left as such. Razak M et al, noted 3 cases of misplaced pedicle screw in their study,which is comparable to our study.

1(5%) patient had superficial wound infection, which was treated with higher antibiotics. Khan. I et al., in their study noted that there was 1 patient with superficial wound infection.

1 (5%) patient had dural puncture per operatively which was repaired with 6-0 prolene

CONCLUSION

This study was conducted to assess the Radiological, Neurological and Clinical outcome of surgical management of thoracolumbar fracture spine with pedicle screws and rod system.

We conclude:

_ Thoracolumbar spine fractures are more common in the 3^{rd} and 4^{th} decade of life with male predominance due to outdoor activities.

_ The commonest mode of injury was fall from a height.

_ The posterior midline approach provides adequate exposure and direct visualization.Blood loss is minimal and operating time is less.

_ Pedicle screw fixation should be done as early as possible in order to facilitate neurological recovery, help in good nursing care and early mobilization of the patient and to prevent deterioration of the neurological status.

_ Pedicle screw instrumentation provides less surgical exposure, correction of deformity and better stabilization .It provides fixation and stabilization of all the three columns.

So pedicle screws and rods helps in stabilization of unstable thoraco-lumbar fractures and gives good neurologic recovery to the patient.

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MASTER CHART

NO	NAME	AGE/ SEX	IP.NO	AO CLASSIFICATION	TLICS SCORE	LEVEL OF INJURY	MODE OF INJURY	ASSOCIATED INJURY	DURATION OF INJURY TO ADMISSION	DURATION OF INJURY TO SURGERY	NEUROLOGICAL ASSESSMENT (ASIA Scale)					RADIOLOGICAL ASSESSMENT						CLINICAL ASSESSMENT		COMPLICATIONS	DURATION OF SURGERY	BLOOD LOSS
											PRE OP	POST OP				REGIONAL ANGLE (in degrees)			ANTERIOR VERTEBRAL HEIGHT (in mm)			DENIS PAIN SCALE	DENIS WORK SACALE			
												1MONTH	3MONTH	6MONTH	1 YEAR	PRE OP	POST OP	LAST VISIT	PRE OP	POST OP	LAST VISIT					
1	SANGEETHA	20/f	60067	A	7	L1	AF	-	1	13	C	D	D	E	E	22	8	11	10	17	16	P1	W1	-	90	300
2	PRAKASH	26/M	39326	B	9	D11	RTA	-	1	6	D	E	E	E	E	14	10	13	18	20	20	P2	W2	-	100	400
3	LAKSHMANAN	47/M	34512	C	7	L1	AF	-	2	9	D	D	E	E	E	16	9	12	22	23	21	P1	W2	-	90	350
4	ANANDHAKUMAR	34/M	58242	A	6	L1	RTA	# RADIAL HEAD.R	1	7	C	D	D	D	E	20	7	11	12	18	16	P3	W2	SCREW MIS-PLACEMENT	120	250
5	AJITHKUMAR	14/M	7874	B	10	L2	AF	-	1	12	C	D	E	E	E	30	6	10	15	25	24	P1	W1	-	110	300
6	ASWINI	15/F	5304	A	7	L1	AF	-	1	10	D	E	E	E	E	20	8	11	14	21	20	P1	W1	-	100	400
7	SEVAPPAYEE	40/F	25404	A	4	D12	RTA	# FIBULA.R	1	16	D	E	E	E	E	30	10	13	12	20	19	P2	W2	-	90	300
8	DHARMALINGAM	31/M	40684	A	6	L1	AF	HI	2	8	D	E	E	E	E	18	9	10	16	22	23	P1	W2	DURAL PUNCTURE	80	350
9	LAKSHMAN	39/M	53530	A	7	D12	AF	HI	1	9	C	D	E	E	E	34	12	13	10	24	22	P2	W3	-	95	450
10	GANESAN	55/M	53020	A	5	L1	AF	-	1	10	D	E	E	E	E	20	4	13	16	17	16	P1	W1	-	125	200

NO	NAME	AGE/ SEX	IP.NO	AO CLASSIFICATION	TLICS SCORE	LEVEL OF INJURY	MODE OF INJURY	ASSOCIATED INJURY	DURATION OF INJURY TO ADMISSION	DURATION OF INJURY TO SURGERY	NEUROLOGICAL ASSESSMENT (ASIA Scale)					RADIOLOGICAL ASSESSMENT						CLINICAL ASSESSMENT		COMPLICATIONS	DURATION OF SURGERY	BLOOD LOSS
											PRE OP	POST OP				REGIONAL ANGLE (in degrees)			ANTERIOR VERTEBRAL HEIGHT (in mm)			DENIS PAIN SCALE	DENIS WORK SACALE			
												1MONTH	3MONTH	6MONTH	1 YEAR	PRE OP	POST OP	LAST VISIT	PRE OP	POST OP	LAST VISIT					
11	PRAKASAM	32/M	30042	A	7	D12	AF	-	1	12	C	D	D	D	E	20	8	11	13	25	23	P1	W2	-	100	300
12	RAMAR	54/M	53790	A	5	L1	RTA	HI	1	13	C	D	D	E	E	20	5	14	10	19	20	P2	W1	-	115	350
13	VENKATRAM	35/M	21766	A	7	L1	RTA	HI	2	16	C	D	E	E	E	18	9	15	12	23	22	P1	W1	-	140	500
14	ELUMALAI	58/M	39426	A	7	L1	AF	-	2	17	C	D	D	D	D	16	10	12	15	20	20	P3	W4	-	85	250
15	PONNUSAMY	55/M	60458	B	8	D12	AF	-	1	10	C	D	D	D	E	12	11	13	19	26	25	P1	W1	-	95	200
16	VINODH	28/M	38560	A	7	L1	AF	-	1	13	D	E	E	E	E	28	7	12	11	23	21	P2	W1	-	100	400
17	SATHYA	20/F	25229	A	4	L1	AF	-	1	16	E	C	D	D	D	32	6	14	9	20	18	P4	W4	ROD PULL OUT	120	450
18	RAMALINGAM	50/M	32460	A	6	L1	AF	# RT CALCANEUM	1	11	C	D	D	E	E	24	8	11	10	24	23	P1	W1	-	90	250
19	GOVINDHI	30/F	41204	A	5	L1	RTA	HI	1	7	E	E	E	E	E	30	10	13	12	21	20-	P1	W2	SWI	105	300
20	ARJUNAN	49/M	55274	A	6	L2	AF	-	2	9	E	E	E	E	E	26	3	12	14	19	19	P2	W2	-	75	250

KEY TO MASTER CHART: D-dorsal vertebra, L-lumbar vertebra, AF-accidental fall, RTA-road traffic accident, HI-head injury, #-fracture

SWI-superficial wound infection, A,B,C,D,E-ASIA Score grades.

ANNEXURE

PROFORMA

NAME: HOSPITAL:

AGE/SEX: UNIT:

FATHER'S NAME: IP. NO:

OCCUPATION: D.O.A:

ADDRESS: D.O.S:

D.O.D:

MODE OF INJURY:

LEVEL OF INJURY:

FRACTURE CLASSIFICATION:

ASSOCIATED INJURIES:

NEUROLOLOGICAL STATUS(ASIA grading)

RADIOLOGICAL ASSESSMENT:

X-RAY:

CT:

MRI:

POST OPERATIVE PERIOD:

ADVICE ON DISCHARGE:

REHABILITATION:

FOLLOW UP

NEUROLOGICAL STATUS: (ASIA grading):

Pre op : Post op:

Follow up :

RADIOLOGICAL FOLLOW UP:

Regional kyphotic angle:

Pre-op: Post-op:

Follow up:

Anterior vertebral height:

Pre-op: Post-op:

Follow up:

CLINICAL ASSESSMENT:

Denis pain scale:

Denis work scale:

BLADDER FUNCTION:

COMPLICATIONS:

MANAGEMENT:

RESULT:

CONSENT FORM FOR ANAESTHESIA/OPERATION

I________________ Hosp No___________ in my full senses hereby give my complete consent for _____________________ or any other procedure deemed fit which is a diagnostic/therapeutic/ procedure/biopsy//transfusion/operation to be performed on me/my/son/daughter/ward_____________ ,age____________under any anaesthesia deemed fit. The nature and risks involved in the procedure have been explained to me in my own language to my satisfaction. For academic and scientific purpose, the operation/ procedure may be television or photographed, or used for statistical measurements.

Date :

Place: Signature/Thumb Impression of the Patient/Guardian

Name :

Relationship :

Full Address :